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QUARTERLY REPORT
OCTOBER 1974-JANUARY 1975
FOR
RIO BLANCO OIL SHALE PROJECT
AQUATIC BASELINE STUDIES

Vol. 2

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Published:	Denver, Colo. : Rio Blanco Oil Shale Project, 1974-1977.
Description:	ill., diagrs., graphs, maps ; 29 cm.
Other Title:	Cover title: Quarterly rept - Rio Blanco Oil Shale Project
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General Note:	Title derived from contents
General Note:	SECTION 1. Geotechnical data gathering project includes : section 1.1 Geologic program ; section 1.2 Hydrologic program -- SECTION 2. Environmental baseline data gathering project includes : section 2.1 Air quality studies ; section 2.2 Meteorologic studies ; section 2.3 Terrestrial ecology studies ; section 2.4 Aquatic ecology studies ; section 2.5 Miscellaneous studies.
Num. Peculiarities:	Quarterly report October 1974 - January 1975
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2.4.6. Sediment Chemistry

Appendix A-12-1 contains the results of chemical analysis of sediment samples obtained during October - November 1974. Appendix A-13-1 contains the results of analysis for selected herbicides in sediment samples collected during the October - November sampling period.

Appendix A-12-2 contains the results of chemical analysis of sediment samples obtained during the December 1974 - January 1975 sampling period, and Appendix A-13-2 contains the results of analysis for selected herbicides in sediment samples. Ice conditions during the sampling period generally inhibited or prohibited collection of sediment samples during the second sampling period.

APPENDIX A-12-1

RESULTS OF SEDIMENT CHEMISTRY ANALYSIS
RBOSP AQUATIC BASELINE STUDIES
OCTOBER - NOVEMBER 1974
(Data are mg/g unless otherwise noted.)

APPENDIX A-12-1[1]

STATION REPLICATE	PARAMETER							
	Al	As	Pb	Hg (µg/g)	KJELDAHL N	TOTAL P	VOLATILE SOLIDS	Zn
1 A	22.3	0.01	0.05	<0.2	2.30	0.95	98.3	0.10
2 A	23.5	0.02	0.06	<0.2	1.60	0.84	85.4	0.09
3 A	17.3	0.01	0.04	0.3	1.20	1.10	110.0	0.06
4 A	16.3	<0.01	0.04	<0.2	1.00	0.94	58.9	0.06
5 A	23.4	<0.01	0.03	<0.2	0.89	0.90	56.7	0.09
7 A	17.2	<0.01	0.04	0.2	1.10	0.71	46.9	0.07
8 A	22.1	0.01	0.04	0.3	0.83	0.96	75.0	0.06
9 A	19.1	0.01	0.03	<0.2	0.73	0.88	45.3	0.06
13 A	21.1	0.01	0.05	0.2	0.75	0.86	65.4	0.09
14 A	27.3	<0.01	0.04	<0.2	1.20	0.92	88.3	0.10
19 A	21.4	<0.01	0.08	<0.2	1.10	0.91	69.6	0.09
20 A	24.3	<0.01	0.05	0.4	0.76	0.61	64.1	0.07
21 A	20.6	<0.01	0.03	0.2	1.00	0.75	42.2	0.07
22 A	21.1	<0.01	0.04	0.3	1.60	0.58	72.0	0.06
23 A	17.7	<0.01	0.04	<0.2	0.89	0.54	38.5	0.07
24 A	13.4	0.01	0.01	0.3	0.39	0.85	23.9	0.06
24 B	13.0	0.01	0.01	0.3	0.76	0.75	53.8	0.06

APPENDIX A-12-1 (Continued)

STATION REPLICATE	PARAMETER							
	Al	As	Pb	Hg (μg/g)	KJELDAHL N	TOTAL P	VOLATILE SOLIDS	Zn
25 A	20.7	0.01	0.51	3.5	0.78	1.10	57.1	0.36
25 B	17.7	0.03	1.00	8.8	1.30	0.95	58.4	0.80
26 A	15.7	<0.01	0.01	0.6	0.67	0.65	43.3	0.10
26 B	19.5	0.01	0.01	0.2	0.42	0.55	33.6	0.08
27 A	11.5	<0.01	0.06	0.4	0.24	0.63	40.2	0.10
27 B	14.7	<0.01	0.03	<0.2	0.29	0.88	34.3	0.07
28 A	16.3	<0.01	0.01	<0.2	0.67	0.85	40.0	0.07
28 B	16.0	<0.01	0.01	<0.2	0.53	0.78	44.0	0.09
29 A	17.2	0.01	0.01	0.2	0.73	0.78	55.2	0.10
29 B	18.3	<0.01	0.01	2.3	0.34	0.85	60.6	0.09
30 A	15.9	<0.01	0.01	<0.2	0.81	0.85	37.7	0.07
30 B	17.6	0.01	0.01	<0.2	0.95	0.80	42.5	0.08
31 A	3.4	<0.01	0.01	<0.2	1.90	0.93	71.0	0.04
31 B	10.3	<0.01	0.01	<0.2	2.70	0.97	78.2	0.06
32 A	16.5	0.01	0.01	<0.2	0.90	0.73	34.7	0.09
32 B	17.1	<0.01	0.01	<0.2	1.10	0.68	49.1	0.08

APPENDIX A-12-1 (Continued)

STATION REPLICATE	PARAMETER							
	Al	As	Pb	Hg (μg/g)	KJELDAHL N	TOTAL P	VOLATILE SOLIDS	Zn
33 A	15.5	<0.01	0.01	<0.2	2.50	0.85	51.9	0.08
33 B	16.4	<0.01	0.01	<0.2	1.20	0.84	59.8	0.07
34 A	17.4	<0.01	0.03	0.4	1.10	0.72	46.8	0.10
34 B	21.4	<0.01	0.05	0.3	1.50	0.79	57.1	0.12
35 A	20.5	<0.01	0.01	0.3	0.89	0.66	39.3	0.08
35 B	20.2	0.01	0.01	<0.2	0.78	0.65	53.6	0.09

[1]Stations 6,10,11,12,15,16,17, and 18 were dry

APPENDIX A-12-2

RESULTS OF SEDIMENT CHEMISTRY ANALYSIS
RBOSP AQUATIC BASELINE STUDIES
DECEMBER 1974 - JANUARY 1975

(Data are μg/g)

APPENDIX A-12-2[1]

STATION REPLICATE	PARAMETER							
	Al	As	Pb	Hg (ppb)	KJELDAHL N	TOTAL P	VOLATILE SOLIDS	Zn
3 A	3200	53	31	887	7600	818	147000	379
4 A	9200	37	28	203	1890	798	67600	47
5 A	12200	26	16	104	1920	657	70500	51
8 A	11200	26	26	27	824	622	44800	54
9 A	7700	35	56	263	1810	630	51600	42
13 A	13800	36	35	392	1490	450	57300	86
14 A	19600	30	33	268	1640	763	69800	66
19 A	12500	11	23	389	1690	602	73400	52
22 A	6800	13	14	1240	329	497	21600	28
23 A	4100	2	11	121	170	414	9300	21
28 A	10000	20	22	500	966	558	42800	44
34 A	4500	6	14	488	677	445	17700	28

[1]Stations 1,2,6,7,10-12,15-18,20,21,24-27,29-33, and 35 were either inaccessible, dry or frozen solid so that no samples could be obtained.

APPENDIX A-13-1

RESULTS OF SEDIMENT HERBICIDE ANALYSIS RBOSP AQUATIC BASELINE STUDIES, OCTOBER - NOVEMBER, 1974
(Data are µg/g)

APPENDIX A-13-1

Station	Parameter	
	Tordon 22K	Silvex
1-A	< 1	< 0.1
2-A	< 1	< 0.1
3-A	< 1	< 0.1
4-A	< 1	< 0.1
5-A	< 1	< 0.1
7-A	1	< 0.1
8-A	< 1	< 0.1
9-A	< 1	< 0.1
13-A	< 1	< 0.1
14-A	< 1	< 0.1
19-A	1	< 0.1
20-A	1	< 0.1
21-A	1	< 0.1
22-A	< 1	< 0.1
23-A	< 1	< 0.1
24-A	2	< 0.1
24-B	2	< 0.1
25-A	< 1	< 0.1
26-A	< 1	< 0.1
26-B	1	< 0.1
27-A	< 1	< 0.1
27-B	< 1	< 0.1
28-A	2	< 0.1
28-B	2	< 0.1
29-A	< 1	< 0.1
30-A	< 1	< 0.1
30-B	1	< 0.1
31-A	< 1	< 0.1
31-B	< 1	< 0.1
32-A	2	< 0.1
32-B	2	< 0.1
33-A	< 1	< 0.1
33-B	< 1	< 0.1
34-A	< 1	< 0.1
34-B	< 1	< 0.1
35-A	1	< 0.1
35-B	1	< 0.1

APPENDIX A-13-2

RESULTS OF SEDIMENT HERBICIDE ANALYSIS RBOSP AQUATIC BASELINE STUDIES, DECEMBER 1974 - JANUARY 1975

(Data are μg/g)

APPENDIX A-13-2

Station Replicate	Parameter
-	Tordon 22K
3-A	1.8
4-A	0.4
5-A	0.5
8-A	0.6
9-A	0.6
13-A	0.3
14-A	0.5
19-A	0.4
22-A	0.4
23-A	0.4
28-A	0.4
34-A	0.4

2.4.7. Macrophytes

2.4.7. Macrophytes

2.4.7.2. Methods

Macrophyte samples are collected every two months using a random transect line system as referenced in Jessen and Lound (1962). Samples are collected simultaneously with the field collection of other biological data.

Samples were taken along randomly chosen transects that cross the streams at each station. All plants within 0.5 meter (∿1.6') upstream and downstream of the transect line were identified and sampled for voucher collection.

The areas covered by major beds of macrophytes upstream and downstream of each site were measured. This was accomplished by tape measurements made while wading in the stream. The major species in each bed was determined, and relative abundance of those species was noted.

Voucher specimens were processed and stored in the herbariun. Taxonomic references are listed at the end of this section.

2.4.7.3. Results

Aquatic macrophytes constitute an important part of the environment of many streams and lakes in Colorado. These plants provide food and cover for numerous mammals, birds, fish, reptiles, amphibians, and invertebrates. Often they are also important in soil stabilization and as a source of oxygen for aquatic life.

Aquatic macrophytes were present in few of the aquatic sampling locations during the October - November 1974 and December 1974 - January 1975 sampling periods.

During October - November, horned pond weed (*Zannichellia palustris* L.) was found growing at a depth of 2 ft(61 cm) along the shore of a pond at Station 14. At Station 5, specimens of marestail (*Hippuris vulgaris* L.) were found growing in 2 ft (61 cm) of water near the edge of a pond; in the narrow, shallow, fast-flowing stream below the pond water cress (*Rorippa nasturtium-aquaticum*) was also found. At Station 19, stonewort (*Chara kieneri*) was quite abundant in a pond area.

During the December - January sampling period, pond weed (*Potamogeton* cf. *foliosus*) and water cress (*Nasturtium officionalis*) were found at Station 8. At the random macrophyte sampling transect crossing the stream at Station 8, pondweed occupied an area 2 ft(61 cm) wide and approximately 3 ft(91 cm) on both the upstream and

downstream sides of the transect. At Station 5, unidentified sedges covered the bottom of the stream for several hundred feet in both the upstream and downstream directions from the sampling transect. At the sampling transect the sedges occupied an area of 19 ft (5.8 m) across the stream and approximately 3 ft (91 cm) on both the upstream and downstream sides of the transect.

2.4.8. Fish

2.4.8. Fish

2.4.8.2. Methods

Electrofishing was the primary sampling method. The unit consisted of a variable voltage AC/DC electrofishing unit driven by a 1500 watt alternator, and two hand held probes (+ and -). Two hundred and twenty volts AC was used at all White River stations except Station 30 where 220 DC was used.

At the White River stations, 100 foot (30.5m) sections of stream were sampled. Due to the variable nature of the substrate, depth, and flow velocity among stations, an identical approach could not be made at all stations. Depending on the character of a station, the electrofishing probes were either moved downstream toward a stationary seine (riffles), or downstream toward dip net handlers (fast runs and pools), or upstream with dip net handlers following (pools). The procedure at each station was reprated twice and the data recorded separately.

The exact sampling procedures employed at each station were:

Station 35

Electroshocked (220 V AC) downstream through 100 foot (30.5 m) section. Collected fish with dip nets. Repeated procedure for second replicate.

Station 34

Electroshocked (220 V AC) downstream through 100 foot (30.5 m) section, then halfway back upstream. Collected fish with dip nets. Repeated procedure for second replicate.

Station 34

Electroshocked (220 V AC) upstream through 100 foot (30.5 m) blocked off section. Collected fish with dip nets. Repeated procedure for secton replicate.

Station 23

Electroshocked (220 V DC) upstream through 100 foot (30.5 m) blocked off section. Collected fish with dip nets. Repeated procedure for second replicate.

Station 24

Electroshocked (220 V DC) downstream through a 100 foot (30.5 m) distance then back upstream through 100 foot (30.5 m) section. Collected fish with dip nets. Repeated procedure for second replicate.

Station 25

Electroshocked (220 V AC) downstream through a 100 foot (30.5 m) section. Collected fish with dip nets. Repeated procedure for second replicate.

Station 26

Same as Station 24 except that 229 V AC was used.

Station 29

Electroshocked (220 V AC) downstream through 100 foot (30.5 m) blocked off section. Collected fish with dip nets and 20 foot (6.1 m) bag seine. Repeated procedure for second replicate.

Station 28

Same as Station 29.

Station 27

Electroshocked (220 V AC) upstream through 100 foot (30.5 m) blocked off section, then immediately back downstream to the bottom block net; collected fish with dip nets. Repeated procedure for second replicate.

Station 32

Electroshocked (220 V AC) downstream through 100 foot (30.5 m) section. Collected fish with dip nets and 20 foot (6.1 m) bag seine. Repeated procedure for second replicate.

Station 30

Electroshocked (220 V AC) downstream through 100 foot (30.5 m) section. Collected fish with dip nets and 20 foot (6.1 m) bag seine. Second replicate electroshocked (220 V AC) (timed) upstream through 100 foot (30.5 m) section. Collected fish with dip nets.

YELLOW CREEK

Station 20

Seined with 10 foot (3 m) seine from bottom to top of a 100 foot (30.5 m) blocked off section. Repeated procedure for second replicate.

Station 21

Worked downstream with dip nets in 100 foot (30.5 m) blocked off section. Repeated procedure for second replicate.

Station 22

Same as Station 20

Sample Processing (Field)

Captured fish were held in 1/8 inch (0.3 cm) mesh "holding nets" (large fish) or buckets of water (small fish) until all sampling was completed at a station. The fish were then weighed to the nearest gram and measured to the nearest millimeter. Stomachs were excised from the larger fish (flannelmouth suckers) and placed in individual jars in 10% formalin. Smaller fishes for stomach analyses (mottled sculpin) were preserved whole in 10% formalin for laboratory processing. Most smaller fishes were preserved in 10% formalin and returned to the laboratory for stomach processing, identification, confirmation, length-weight measurements and voucher collection purposes. Scales were taken from flannelmouth suckers and placed in individual envelopes, with all appropriate data recorded on the envelopes.

Fish returned to the laboratory were weighed to the nearest 0.1 gram and measured to the nearest millimeter. Questionable identifications were checked with the aid of keys by Beckman ([1952]) and Ellis (1914). All specimens were retained for voucher purposes.

Stomachs were slit open and the contents examined under a dissecting microscope. For each stomach examined, the data recorded were: 1) estimate of % fullness of stomach, 2) number of each type of food item, 3) length and weight of specimen from which stomach was taken. Identifications of food items were made to the lowest possible taxonomic level.

Fish scales were stained with Alizarin Red S, permanently mounted on glass slides and examined under a microprojector. The criteria of Tesch (1968) were used to determine the presence of annular marks. Number of annular marks and distances from each mark to the scale focus were recorded.

2.4.8.3. Results

Fish data from the October - November 1974 sampling are presented in Appendices A-14-1 through A-14-8. No fish were collected during the second sampling period.

During the October - November 1974 sampling approximately 500 fish representing nine species were captured in the White River and lower Yellow Creek. About 60 percent of these specimens were returned to the streams, with the remainder being retained for further analysis. The major portion of the catch was composed of flannelmouth and bluehead sucker, speckled dace, fathead minnow, and mottled sculpin. The catch was thus dominated by rough and forage fishes. The catches in the White River and Yellow Creek were similar, except that suckers captured in Yellow Creek were small. Fish data from the October - November 1974 sampling are presented in Appendices A-15-1 through A-15-8.

APPENDIX A-14-1

LIST OF FISH SPECIES AND NUMBERS CAPTURED
IN THE WHITE RIVER AND LOWER YELLOW CREEK
RBOSP AQUATIC BASELINE STUDIES
OCTOBER - NOVEMBER 1974

APPENDIX A-14-1

Common Name	Scientific Name	Number Captured
Rainbow trout	*Salmo gairdneri*	1
Brown trout	*Salmo trutta*	1
Mountain whitefish	*Prosopium williamsoni*	7
Fathead minnow	*Pimephales promelas*	90
Longnose dace	*Rhinichthys cataractae*	4
Speckled dace	*Rhinichthys osculus*	122
Bluehead sucker	*Catostomus discobolus*	26
Flannelmouth sucker	*Catostomus latipinnis*	58
Mottled sculpin	*Cottus bairdi*	233

APPENDIX A-14-2

MEAN CONDITION FACTORS FOR THREE
SPECIES OF FISH CAPTURED IN THE WHITE RIVER
DURING RBOSP AQUATIC BASELINE STUDIES
OCTOBER - NOVEMBER 1974

APPENDIX A-14-2

Species	Number of Specimens	Length Range (mm)	Mean K_{TL}
Mottled sculpin	21	49 - 109	14.0
Flannelmouth sucker	29	50 - 491	8.6
Moutain whitefish	4	122 - 131	9.2

APPENDIX A-14-3

RESULTS OF SCALE ANALYSIS OF
FLANNELMOUTH SUCKERS TAKEN IN THE WHITE RIVER
DURING RBOSP AQUATIC STUDIES
OCTOBER - NOVEMBER 1974

APPENDIX A-14-3

Length (mm)	Weight (gm)	Age Class
116	18	0
393	561	3
396	544	3
397	554	3
389	499	3
338	320	3
423	703	3
400	522	4
415	664	4
414	617	4
373	450	4
384	479	4
470	792	4
436	759	5
491	864	5
456	755	5
395	549	5
480	974	6

APPENDIX A-14-4

SUMMARY OF STOMACH CONTENT ANALYSIS FOR
MOTTLED SCULPIN TAKEN IN THE WHITE RIVER
DURING RBOSP AQUATIC BASELINE STUDIES
OCTOBER - NOVEMBER 1974

APPENDIX A-14-4

Food Type	% Frequency of Occurrence[1]	% of Total Food Items[2]
Hydropsychidae	84	45
Baetidae	48	32
Chironomidae	48	17
Oligochaeta	12	2
Simuliidae	8	1
Ceratopogonidae	4	<1
Coenagrionidae	4	<1
Hydroptilidae	4	<1
Pyralidae	4	<1
Heptageniidae	4	<1
Tabanidae	4	<1
Coleoptera	4	<1
Fish	4	1
debris	44	-

[1] % frequency of occurrence = $\frac{\text{\# stomachs containing food item}}{\text{total \# stomachs examined}}$

[2] % of total food items = $\frac{\text{total \# of a food taxon in all stomachs}}{\text{total \# of all food items}}$

APPENDIX A-14-5

SUMMARY OF STOMACH CONTENT ANALYSIS
FOR FLANNELMOUTH SUCKERS TAKEN IN THE
DURING RBOSP AQUATIC BASELINE STUDIES
OCTOBER - NOVEMBER 1974

APPENDIX A-14-5

Food Type	% Frequency[1] of Occurrence	% of Total[2] Food Items
Plecoptera[3]	40	45
Ephemeroptera[3]	40	30
Hydropsychidae	40	4
Baetidae	40	2
Diptera[3]	20	2
Trichoptera[3]	20	1
Chironomidae	80	<1
Simuliidae	40	<1
Pyralidae	20	<1
debris	60	-

[1] % frequency of occurrence = $\frac{\text{\# stomachs containing food item}}{\text{total \# stomachs examined}}$

[2] % of total food items = $\frac{\text{total \# of a food taxon in all stomachs}}{\text{total \# of all food items}}$

[3] early instars

APPENDIX A-14-6

FISH OBSERVED IN THE WHITE RIVER AND LOWER YELLOW CREEK
RBOSP AQUATIC BASELINE STUDIES, OCTOBER - NOVEMBER 1974

APPENDIX A-14-6

Date	Station	Replicate	Species	Length (mm)	Weight (gm)
10-14-74	White River	(Qualitative near station 27)	Mottled sculpin	81	7.7
			Flannelmouth sucker	326	322
			Bluehead sucker	389	521
			"	74	3.2
			$\bar{x}$ =	232	262.1
			Longnose dace	68	3.0
			Speckled dace	45	1.0
10-14-74	White River	(Qualitative near station 27)	Mottled sculpin	109	21.2
			"	104	18.1
			"	101	17.8
			"	89	10.5
			"	84	8.7
			"	65	4.3
			"	57	2.3
			$\bar{x}$	87	11.8
			Flannelmouth sucker	482	893
			"	460	821
			"	403	541
			"	384	488
			"	373	410
			"	346	321
			"	92	7.0
			$\bar{x}$	363	497
			Speckled dace	45	1.0
			"	45	0.9
			"	40	0.6
			$\bar{x}$	43	0.8
10-30-74	20	1	Flannelmouth sucker	47	0.9
			"	46	1.1
			"	43	0.9
			"	43	0.8
			"	42	0.8
			"	40	0.6
			"	36	0.6
			"	35	0.4
			$\bar{x}$	42	0.8
			Bluehead sucker	33	0.3
10-30-74	20	2	Flannelmouth sucker	54	2.0
			"	43	0.7
			"	42	0.7
			$\bar{x}$	46	1.1
			Bluehead sucker	35	0.6

APPENDIX A-14-6 (Continued)

Date	Station	Replicate	Species	Length (mm)	Weight (gm)
10-30-74	20	2	Speckled dace	45	0.9
			"	40	0.8
			"	35	0.6
			$\bar{x}$	40	0.8
			Fathead minnow	47	1.4
			"	47	1.4
			"	43	0.9
			$\bar{x}$	46	1.2
			Unidentifiable	35	0.4
10-30-74	21	1	Bluehead sucker	39	0.5
			Speckled dace	39	0.8
			"	29	0.2
			$\bar{x}$	34	0.5
			Fathead minnow	46	1.1
10-30-74	21	2	Flannelmouth sucker	53	1.4
			Bluehead sucker	38	0.5
			Speckled dace	46	1.0
			"	38	0.6
			"	38	0.5
			$\bar{x}$	41	0.1
10-29-74	22	1	Flannelmouth sucker	48	1.0
			"	41	0.7
			$\bar{x}$	45	0.9
			Bluehead sucker	42	0.8
			"	39	0.6
			"	33	0.3
			"	32	0.3
			"	28	0.1
			$\bar{x}$	35	0.4
			Speckled dace	35	0.3
			"	29	0.2
			"	27	0.2
			"	26	0.2
			"	25	0.2
			$\bar{x}$	28	0.2
10-29-74	22	2	Flannelmouth sucker	46	0.6
			"	40	0.5
			"	40	0.5
			"	38	0.5
			"	37	0.4
			$\bar{x}$	40	0.5

APPENDIX A-14-6 (Continued)

Date	Station	Replicate	Species	Length (mm)	Weight (gm)
10/29/74	22	2	Bluehead sucker	38	0.5
			"	35	0.4
			$\bar{x}$	37	0.5
			Speckled dace	31	0.3
			"	18	0.1
			$\bar{x}$	25	0.2
11- 74	23	1	Flannelmouth sucker	395	549
11-74	23	2	Mottled sculpin	100	8
			"	63	2
			"	55	2
			"	51	2
			$\bar{x}$	61	2.4
			Flannelmouth sucker	109	9
			Speckled dace	41	0.7
			Brown trout	138	27
10-17-74	24	1	Mottled sculpin	92)	
			"	68)	
			"	65)	
			"	60)	
			"	60)	
			"	59)	
			"	59)	
			"	57)	31
			"	55)	
			"	53)	
			"	53)	
			"	50)	
			"	50)	
			$\bar{x}$	60	2.4
			Speckled dace	57)	
			"	49)	
			"	48)	
			"	45)	
			"	45)	
			"	45)	
			"	45)	
			"	44)	
			"	43)	17
			"	42)	
			"	42)	
			"	41)	
			"	41)	
			"	38)	
			"	34)	
			$\bar{x}$	44	1.0
			Fathead minnow	57	1.0

APPENDIX A-14-6 (Continued)

Date	Station	Replicate	Species	Length (mm)	Weight (gm)
10-17-74	24	2	Mottled sculpin	66	3.6
			"	61	3.0
			"	58	2.3
			"	56	2.4
			"	56	2.1
			"	55	2.2
			"	55	2.1
			"	53	2.1
			"	53	1.8
			"	49	1.6
			$\bar{x}$	56	2.3
10-17-74	24	2	Flannelmouth sucker	50	1.2
			Speckled dace	47	1.2
			"	46	1.0
			"	46	1.0
			"	42	0.8
			"	40	0.8
			"	37	0.5
			"	35	0.5
			"	35	0.4
			"	30	0.3
			"	28	0.2
			"	27	0.2
			$\bar{x}$	37	0.6
			Fathead minnow	55	1.9
			"	55	1.7
			"	44	0.9
			"	42	0.7
			$\bar{x}$	49	1.3
10-17-74	25	1	Mottled sculpin	97)	
			"	88)	39
			"	87)	
			"	62)	
			$\bar{x}$	84	9.8
			Speckled dace	43	<1
10-17-74	25	2	Mottled sculpin	110	15.0
			"	102	5.0
			$\bar{x}$	106	5.3

APPENDIX A-14-6 (Continued)

Date	Station	Replicate	Species	Length (mm)	Weight (gm)
10-17-74	26	1	Mottled scuplin	116	
			"	105	
			"	99	
			"	98	
			"	98	
			"	93	
			"	93	
			"	87	
			"	87	
			"	86	
			"	84	
			"	84	
			"	68	
			"	67	
			"	67	
			"	66	
			"	65	
			"	64	
10-17-74	26	1	Mottled sculpin	63	
			"	63	
			"	62	
			"	62	
			"	61	
			"	61	(total wt = 200.0)
			"	61	
			"	58	
			"	58	
			"	57	
			"	54	
			"	53	
			"	50	
			"	49	
			$\bar{x}$	73	6.3
10-17-74	26	2	Mottled sculpin	121)	
			"	83)	33.0
			"	66)	
			"	60)	
			$\bar{x}$	83	8.3
			Speckled dace	45)	
			"	41)	<1
			$\bar{x}$	43	

APPENDIX A-14-6 (Continued)

Date	Station	Replicate	Species	Length (mm)	Weight (gm)
10-16-74	27	1	Mottled sculpin	101	14.3
			"	62	3.2
			"	60	2.8
			"	59	3.1
			$\bar{x}$	71	5.9
			Flannelmouth sucker	491	864
			"	64	2.1
			"	59	1.8
			$\bar{x}$	205	289.3
			Speckled dace	50	1.3
			"	44	0.9
			"	39	0.7
			"	38	0.5
			"	35	0.5
			"	33	0.5
			"	30	0.3
			$\bar{x}$	38	0.7
			Fathead minnow	58	2.4
			"	57	2.3
			"	55	1.9
			"	53	1.7
			"	50	1.7
10-16-74	27	1	Fathead minnow	49	1.5
			"	49	1.3
			"	48	1.2
			"	47	1.2
			"	46	1.0
			"	46	1.0
			"	44	1.0
			"	44	0.9
			"	44	1.1
			"	43	1.0
			"	43	1.0
			"	43	0.8
			"	42	0.9
			"	39	0.7
			"	39	0.6
			"	36	0.4
			$\bar{x}$	46	1.2

APPENDIX A-14-6 (Continued)

Date	Station	Replicate	Species	Length (mm)	Weight (gm)
			Mountain whitefish	131	19.8
			"	128	18
			"	127	19
			"	122	17.4
			$\bar{x}$	127	18.6
10-16-74	27	2	Mottled sculpin	90	11.4
			"	64	3.9
			$\bar{x}$	77	7.7
			Flannelmouth sucker	470	79.2
			"	58	1.9
			"	50	0.9
			$\bar{x}$	193	264.9
			Bluehead sucker	40	0.5
			Speckled dace	38	0.5
			"	37	0.6
			"	34	0.4
			"	34	0.5
			"	30	0.3
			"	28	0.2
			"	26	0.1
			$\bar{x}$	32	0.4
			Fathead minnow	48	1.4
			"	46	0.8
			"	43	0.8
			"	42	0.7
			"	40	0.7
			"	36	0.4
			$\bar{x}$	43	0.8
10-6-74	27	2	Mountain whitefish	131	19.2
			"	127	19.4
			"	123	17.1
			$\bar{x}$	127	18.6
10-16-74	28	1	Mottled sculpin	58	2.7
			"	57	2.6
			$\bar{x}$	58	2.7
			Flannelmouth sucker	59	2.0
			"	54	1.3
			"	48	0.8
			"	46	0.8
			$\bar{x}$	52	1.2

APPENDIX A-14-6 (Continued)

Date	Station	Replicate	Species		Length (mm)	Weight (gm)
			Bluehead sucker		24	0.1
			Speckled dace		45	1.0
			"		43	0.9
			"		42	0.8
			"		42	0.8
			"		40	0.7
				$\bar{x}$	42	0.8
			Fathead minnow		62	2.6
			"		61	2.4
			"		48	1.2
			"		47	1.1
			"		44	1.1
			"		41	0.7
				$\bar{x}$	51	1.5
10-16-74	28	2	Mottled sculpin		69	4.8
			"		55	1.9
				$\bar{x}$	62	3.4
			Bluehead sucker		85	7.7
			Speckled dace		38	0.6
			Fathead minnow		65	3.3
			"		53	1.8
			"		53	1.7
			"		52	1.5
			"		49	1.3
			"		48	1.2
			"		48	1.2
			"		46	1.1
			"		46	1.0
			"		46	0.8
			"		45	1.1
			"		44	1.0
			"		43	0.8
			"		41	0.7
10-16-74	28	2	Fathead minnow		41	0.6
			"		37	0.5
				$\bar{x}$	47	1.2
10-16-74	28	(Qualitative)	Mottled sculpin		78	7.0
			"		64	3.4
			"		51	1.9
				$\bar{x}$	64	4.1

APPENDIX A-14-6 (Continued)

Date	Station	Replicate	Species	Length (mm)	Weight (gm)
			Flannelmouth sucker	54	1.2
			Bluehead sucker	76	4.8
			"	49	1.2
			$\bar{x}$	63	3.0
			Fathead minnow	62	2.9
			"	56	1.7
			"	48	1.3
			"	48	1.2
			"	47	1.2
			"	47	1.0
			"	46	1.1
			"	45	1.0
			"	45	0.9
			"	45	0.9
			"	45	0.9
			"	44	0.9
			"	44	0.9
			"	44	0.9
			"	44	0.8
			"	44	0.8
			"	43	0.9
			"	39	0.6
			"	39	0.6
			"	39	0.5
			"	37	0.5
			$\bar{x}$	45	1.0
10-15-74	29	1	Mottled sculpin	100	15.4
			"	93	13.0
			"	88	10.9
			"	86	9.5
			"	86	9.5
			"	68	4.6
			"	64	4.3
			"	64	4.5
			"	63	3.8
			"	63	3.5
			"	62	3.7
			"	62	3.5
			"	62	4.1
			"	62	4.1

APPENDIX A-14-6 (Continued)

Date	Station	Replicate	Species	Length (mm)	Weight (gm)
10-15-74	29	1	Mottled sculpin	61	3.6
			"	61	3.6
			"	61	3.5
			"	61	3.5
			"	61	3.6
			"	59	3.2
			"	58	3.8
			"	57	2.9
			"	57	2.6
			"	56	2.8
			"	56	2.8
			"	55	2.8
			"	55	2.7
			"	53	2.5
			"	52	2.5
			"	52	2.3
			"	50	2.0
			"	49	2.0
			"	49	2.0
			"	49	1.9
			"	46	1.6
			$\bar{x}$	64	4.3
			Flannelmouth sucker	50	1.4
			Speckled dace	48	1.5
			"	46	1.3
			"	44	1.1
			"	44	1.2
			"	44	1.2
			"	43	1.2
			"	42	1.0
			"	42	1.0
			"	42	0.8
			"	41	1.0
			"	41	0.9
			"	41	0.9
			"	40	1.0
			"	40	0.9
			"	39	0.9
			"	39	0.9
			"	34	0.7
			$\bar{x}$	44	1.0
			Fathead minnow	46	1.3
			Rainbow trout	421	-

APPENDIX A-14-6 (Continued)

Date	Station	Replicate	Species		Length (mm)	Weight (gm)
10-15-74	29	2	Mottled sculpin		67	4.3
			"		62	3.4
			"		61	3.2
			"		61	3.1
			"		60	2.7
			"		58	2.7
			"		58	2.7
			"		58	2.4
			"		56	2.3
			"		56	2.2
			"		55	2.3
			"		55	2.3
			"		48	1.5
			"		45	1.2
				$\bar{x}$	57	2.6
			Speckled dace		45	0.9
			"		44	0.8
			"		42	0.8
			"		40	0.6
			"		39	0.6
			"		36	0.5
			"		33	0.4
			"		33	0.4
				$\bar{x}$	39	0.6
			Fathead minnow		45	0.9
10-15-74	29	Qualitative	Mottled sculpin		80	7.4
			"		62	3.5
			"		61	3.7
			"		61	3.4
			"		59	3.2
			"		58	2.8
			"		53	2.0
			"		52	2.0
				$\bar{x}$	61	3.5
			Speckled dace		49	1.3
			"		47	1.0
			"		37	1.1
			"		47	1.0
			"		46	1.2
			"		46	0.8
			"		45	0.9
			"		45	0.9
			"		44	0.9
			"		43	0.7
			"		42	0.7
			"		42	0.7
			"		41	0.7

APPENDIX A-15-6 (Continued)

Date	Station	Replicate	Species		Length (mm)	Weight (gm)
10-15-74	29	Qualitative	Speckled dace		39	0.7
			"		35	0.4
				$\bar{x}$	44	0.9
			Fathead minnow		49	1.2
10-18-74	30	1	Mottled sculpin		108	20.6
			"		102	15.6
			"		98	16.1
			"		98	14.3
			"		93	11.6
			"		91	13.3
			"		68	5.7
			"		68	4.3
			"		65	4.2
			"		62	3.5
			"		61	3.7
			"		60	3.4
			"		58	3.1
			"		54	2.3
			"		52	2.3
			"		52	2.0
			"		48	1.7
				$\bar{x}$	83	7.5
			Bluehead sucker		90	7.3
			"		88	7.4
			"		82	5.6
				$\bar{x}$	87	6.8
10-18-74	30	2	Mottled sculpin		90	11.8
			"		67	4.4
			"		65	4.0
			"		64	4.2
			"		62	3.5
			"		61	3.4
			"		58	3.0
			"		49	1.7
				$\bar{x}$	65	4.5
			Bluehead sucker		95	9.0
			"		87	7.0
				$\bar{x}$	91	8.0
			Speckled dace		48	1.2
			"		45	1.0
				$\bar{x}$	47	1.1
			Fathead minnow		54	1.9

APPENDIX A-14-6 (Continued)

Date	Station	Replicate	Species	Length (mm)	Weight (gm)
10-18-74	31	1	Mottled sculpin	102)	
			"	88)	
			"	69)	
			"	67)	46
			"	66)	
			"	57)	
			$\bar{x}$	75	7.6
			Speckled dace	42	1
			Bluehead sucker	98	10
10-18-74	31	2	No fish		
10-18-74	32	1	Mottled sculpin	105	19.1
			"	90	10.8
			"	69	4.6
			"	64	3.8
			"	62	3.1
			"	55	2.4
			"	55	2.3
			$\bar{x}$	71	6.6
			Longnose dace	77	3.4
			Speckled dace	45	0.9
			"	41	0.6
			"	40	0.7
			"	39	0.6
			"	32	0.3
			$\bar{x}$	39	0.6
			Fathead minnow	50	1.4
			"	41	0.7
			$\bar{x}$	46	1.0
10-18-74	32	2	Mottled sculpin	103)	
			"	67)	
			"	64)	21
			"	61)	
			$\bar{x}$	74	5.3
			Flannelmouth sucker	59	1.7
			Bluehead sucker	85	5.7
			"	50	1.3
			$\bar{x}$	68	3.5

APPENDIX A-14-6 (Continued)

Date	Station	Replicate	Species	Length (mm)	Weight (gm)
10/18/74	32	2	Speckled dace	44	-
			"	41	0.7
			"	40	0.6
			"	39	0.6
			"	37	0.5
			$\bar{x}$	40	0.6
			Fathead minnow	49	1.4
			"	48	1.3
			"	47	1.0
			"	42	-
			$\bar{x}$	47	-
10-19-74	33	1	Mottled sculpin	62)	
			"	59)	8
			$\bar{x}$	61	4
			Flannelmouth sucker	436	759
			"	423	703
			"	415	664
			"	400	522
			"	397	554
			"	396	544
			"	393	561
			"	389	499
			"	338	320
			$\bar{x}$	399	569.6
			Longnose dace	74	
10-19-74	33	2	Flannelmouth sucker	456	755
			"	373	450
			"	116	18
			$\bar{x}$	315	407.7
10-19-74	34	1	Mottled sculpin	89)	
			"	66)	
			"	64)	
			"	63)	29
			"	60)	
			"	58)	
			"	58)	
			"	57)	
			"	54)	
			$\bar{x}$	57	3.2
			Longnose dace	109	10

APPENDIX A-14-6 (Continued)

Date	Station	Replicate	Species	Length (mm)	Weight (gm)
10-19-74	34	2	Mottled sculpin	111)	
			"	50)	23
			$\bar{x}$	81	11.5
			Flannelmouth sucker	414	617
10-19-74	35	1	Mottled sculpin	107)	
			"	85)	
			"	65)	
			"	61)	36
			"	58)	
			$\bar{x}$	75	7.2
			Flannelmouth sucker	480	974
			Longnose dace	103	8.2
10-19-74	35	2	Mottled sculpin	107)	
			"	100)	
			"	98)	
			"	92)	
			"	89)	
			"	89)	87
			"	88)	
			"	70)	
			"	67)	
			"	64)	
			"	56)	
			$\bar{x}$	84	7.9
			Flannelmouth sucker	384	479

Note:) indicates fishes whose weights are combined.

APPENDIX A-14-7

COMBINED FISH MEASUREMENT DATA FOR WHITE RIVER
AND LOWER YELLOW CREEK. RBOSP AQUATIC BASELINE STUDIES
OCTOBER - NOVEMBER 1974

APPENDIX A-14-7

Species	Number	Mean Length (mm)	Length Range (mm)	Mean Weight (g)	Weight Range (g)
Mottled sculpin	233	65	45 - 121	1.2	5.0 - 21.2
Flannelmouth sucker	58	200	35 - 491	249.5	0.4 - 893
Bluehead sucker	26	52	24 - 389	23.0	0.1 - 521
Longnose dace	4	82	68 - 109	21.4	3.0 - 10
Speckled dace	122	40	26 - 57	0.8	0.1 - 1.5
Fathead minnow	90	46	36 - 65	1.2	0.4 - 3.5
Mountain whitefish	7	127	122 - 131	18.6	17.1 - 19.8
Brown trout	1	138	-	27.0	-
Rainbow trout	1	421	-	-	-

APPENDIX A-14-8

RESULTS OF FOOD HABITAT ANALYSIS
FOR INDIVIDUAL FISH
RBOSP AQUATIC BASELINE STUDIES
OCTOBER - NOVEMBER 1974

APPENDIX A-14-8

Species	Length (mm)	Weight (gm)	% Fullness[1]	Food Items #	Food Items Type
Station 18, replicate 2, 10/17/74					
Mottled sculpin	53	1.8	95	6	Chironomidae
				1	Ceratopogonidae
Mottled sculpin	58	2.3	95	6	*Hydropsyche* sp.
				6	Chironomidae
				1	Coenagrionidae
				1	Hydroptilidae
Mottled sculpin	66	3.6	95	1	*Hydropsyche* sp.
				-	Insect parts
Station 21, replicate 1, 10/16/74					
Mottled sculpin	101	14.3	85	4	Hydropsychidae
				-	Insect parts
Flannelmouth sucker	491	864.0	50	3	Simuliidae
				1	Chironomidae
				14	Hydropsychidae
Station 21, replicate 2, 10/16/74					
Mottled sculpin	90	11.4	80	2	Pyralidae
				2	Chironomidae
				4	Hydropsychidae
Flannelmouth sucker	470	792.0	33	3	Chironomidae
				20	Hydropsychidae
				2	Baetidae (1 confirmed *Traverella* sp.)
				1	Simuliidae

APPENDIX A-14-8 (Continued)

Station 23, replicate 1, 10/15/74

Species	Length (mm)	Weight (gm)	% Fullness	Food Items #	Food Items Type
Rainbow trout	421	-	30	39	*Sigara* sp.
				1	*Notonecta* sp.
				7	Baetidae
				2	Heptageniidae *Stenonema* sp.
				1	Formicidae
				2	Ephemeroptera (adult)
				4	*Amphiagrion* sp.
				1	*Argia* sp.
				2	Adult terrestrial insects
				-	Vegetable material, chiefly *Spirogyra* sp. constituted 60% of stomach contents
Mottled sculpin	93	13.0	90	10	Hydropsychidae
				-	Insect parts
Mottled sculpin	88	10.9	90	3	Hydropsychidae
				12	Baetidae (3 confirmed *Baetis* sp.)
				1	Chironomidae
				1	Simuliidae
Mottled sculpin	100	15.4	85	-	Insect parts, mostly Hydropsychidae

APPENDIX A-14-8 (Continued)

Species	Length (mm)	Weight (gm)	% Fullness	Food Items #	Food Items Type
			Station 23, replicate 2, 10/15/74		
Mottled sculpin	61	3.1	100	2	Baetidae
				1	Hydropsychidae
				3	Chironomidae (2 orthocladiinae, 1 Tanytarsini)
				-	Debris
Mottled sculpin	55	2.3	100	1	Chironomidae (Tanytarsini)
				19	Baetidae (2 confirmed *Traverella*
				1	Heptageniidae
				2	Simuliidae
				3	*Hydropsyche* sp.
Mottled sculpin	45	1.2	0	-	-
			Station 23, qualitatitve sample, 10/16/74		
Mottled sculpin	80	7.4	85	5	Baetidae
				3	Hydropsychidae
				1	Tabanidae
				-	Debris
			Station 24, replicate 1, 10/16/74		
Mottled sculpin	91	13.3	85	1	Baetidae (*Traverella* sp.)
				12	Hydropsychidae
Mottled sculpin	108	20.6	90	11	Baetidae
				6	Hydropsychidae

APPENDIX A-14-8 (Continued)

Species	Length (mm)	Weight (gm)	% Fullness	Food Items #	Food Items Type
			Station 24, replicate 1 (continued)		
Mottled sculpin	98	16.1	90	7	Hydropsychidae
				2	Baetidae
				1	Chironomidae
Mottled sculpin	98	14.1	60	8	*Hydropsyche* sp.
Mottled sculpin	93	11.6	85	5	Baetidae
				10	*Hydropsyche* sp.
				3	Chironomidae
Mottled sculpin	102	15.6	85	4	*Hydropsyche* sp.
				4	Baetidae
				-	Debris
			Station 24, replicate 2, 10/16/74		
Mottled sculpin	90	11.8	85	6	Baetidae
				4	Hydropsychidae
				1	Chironomidae
				-	Insect parts
			Station 26, replicate 1, 10/18/74		
Mottled sculpin	90	10.8	100	4	Hydropsychidae (1 confirmed *Hydropsyche* sp.)
				1	Chironomidae (Tanytarsini)
				1	Coleoptera
Mottled sculpin	105	19.1	100	1	Fish (constituted 99% of content)
				-	Hemiptera wings

APPENDIX A-14-8 (Continued)

Species	Lenght (mm)	Weight (gm)	% Fullness	Food Items #	Food Items Type	
Station 28, replicate 2, 10/19/74						
Flannelmouth sucker	414	617.0	25	117	Simuliidae)	
				3	Chironomidae)	20%
(Specimen contained 20 Caryophyllaeus sp. tapeworms)				1	Pyralidae)	
				-	Debris	80%
Station 29, replicate 1, 10/19/74						
Flannelmouth sucker	480	974.0	50	332	Plecoptera)	
				149	Ephemeroptera)	mostly
				12	Trichoptera)	early
				21	Diptera)	instars
				-	Debris (40% of total)	
Station 29, replicate 2, 10/19/74						
Flannelmouth sucker	384	479.0	50	49	Plecoptera)	1st
				102	Ephemeroptera)	instars
(Specimen contained 21 Caryophyllaeus sp. tapeworm)				13	Baetidae (*Baetis* sp.)	
				1	Chironomidae	
					Debris (50% of contents)	
Qualitative sampling, upstream from station 21, 10/14/74						
Mottled sculpin	92	7.0	10	13	Chironomidae (1 was (*Microtendipes* sp.)	
				1	Oligochaeta	
Mottled sculpin	109	21.2	100	10	Hydropsychidae	
				2	Oligochaeta	
				-	Insect parts (80%)	

APPENDIX A-14-8 (Continued)

Species	Length (mm)	Weight (gm)	% Fullness	Food Items #	Food Items Type
Qualitative sampling, upstream from station 21 (Continued)					
Mottled sculpin	57	2.3	100	5	Baetidae
				6	*Hydropsyche* sp.
				5	Chironomidae
				2	Oligochaeta
				-	Insect parts (50%)
Qualitative sampling, White River near Yellow Creek, 10/14/74					
Mottled sculpin	81	7.7	85	10	Hydropsychidae
				10	Baetidae

[1] % fullness is the percent of apparently available space in the stomach (when empty) taken up by the contents.

2.4.9. Springs & Seeps

2.4.9. Springs and seeps

Springs and seepages are studied to determine occurrence and location. Methods involve analysis of color infrared photography and field investigations. Locations of springs and seeps on or near Tract C-a are shown on Figure 3.

2.4.10. Hydrology

As indicated in Appendix A-1-1, a total of seven sampling sites were dry during the October - November 1974 sampling period. The approximate stream velocities at the other sampling stations are presented in Appendix A-15-1.

As indicated in Appendix A-1-2, a total of eleven sampling sites were inaccessible, dry or frozen solid during the December 1974 - January 1975 sampling period. The approximate stream velocities at the other sampling stations are presented in Appendix A-15-2.

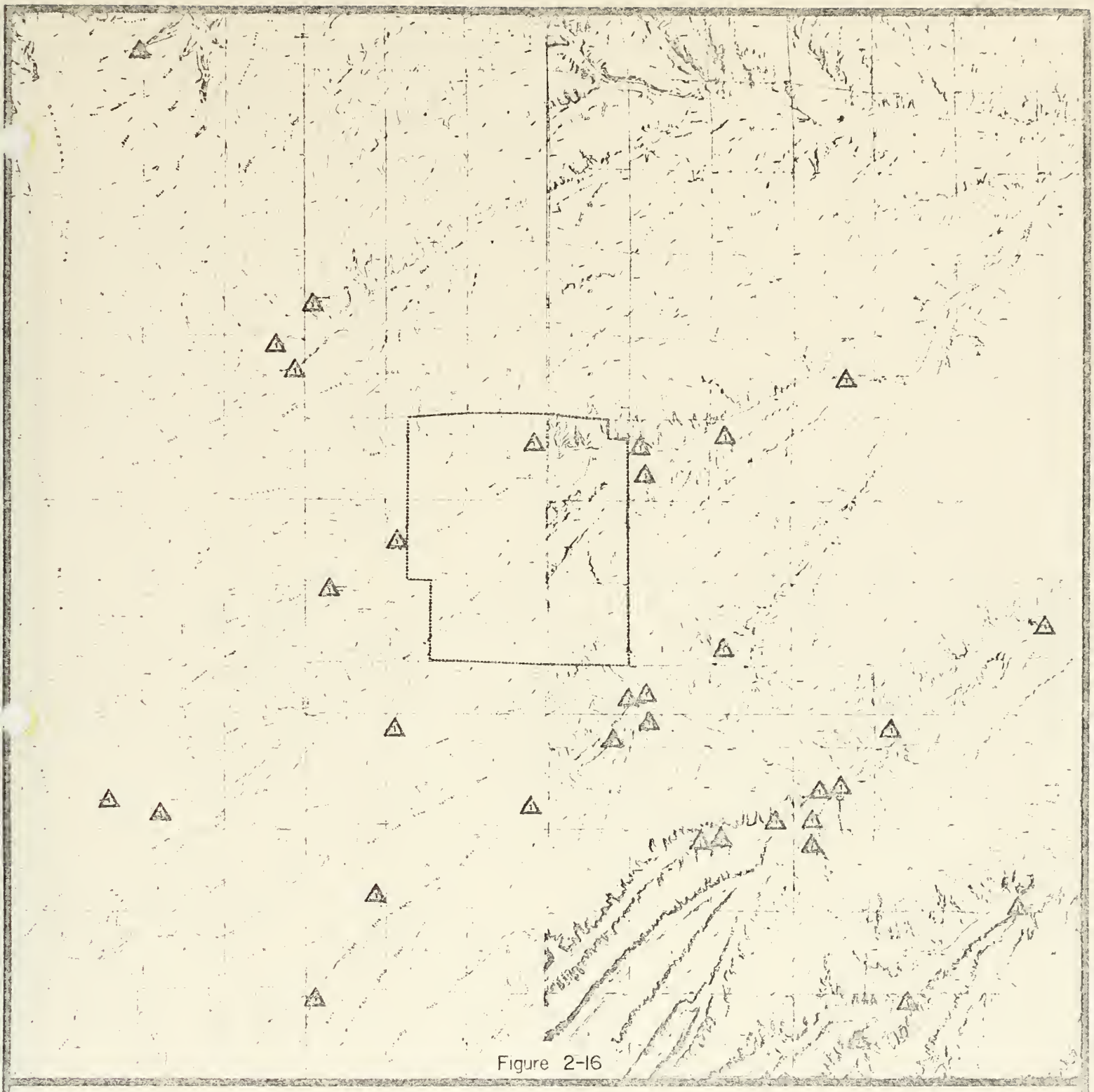

Figure 2-16

ENVIRONMENTAL STUDIES FOR THE RIO BLANCO OIL SHALE PROJECT

TRACT C-a

SPRING & SEEPAGE LOCATIONS

△ springs and seepages as of 3/75

N

LIMNETICS, INC.
Denver, Colorado

3/75

MILES
0 1/2 1 2

APPENDIX A-15-1

STREAM FLOWS OBSERVED DURING RBOSP AQUATIC BASELINE STUDIES, OCTOBER-NOVEMBER 1974
(Results are expressed in feet per second, and where appropriate are given for bank sides and point of maximum flow.)

APPENDIX A-15-1[1]

Station	Flow Rate
1	0.5
2	1.4
3	0.5
4	0.9; 0.4
5	1.3
7	1.0; 0.5
8	1.0
9	1.5
13	0.5; 0.5; 0.6
14	1.3
19	2.8
20	1.7
21	0.8; 1.4; 0.2
22	1.0; 0.8; 0.2
23	2.9; 3.3; 1.4
24	1.7; 3.2; 1.2
25	1.7; 3.2; 1.2
26	1.7; 3.2; 1.2
27	0.4; 0.4; 0.6
28	1.0; 1.4; 0.5
29	3.4; 2.3
30	0.8; 2.8; 1.9
31	0.8; 2.8; 1.9
32	0.8; 2.8; 1.9
33	0.3; 1.4; 1.0
34	2.7; 3.0; 2.0
35	3.4; 4.3; 2.5

[1]Stations 6, 10-12, and 15-18 were dry at the time of sampling.

APPENDIX A-15-2

STREAM FLOWS OBSERVED DURING RBOSP AQUATIC BASELINE STUDIES, DECEMBER 1974 - JANUARY 1975
(Results are expressed in feet per second, and where appropriate are given for bank sides and point of maximum flow.)

APPENDIX A-15-2[1]

Station	Flow Rate
3	0.3
4	0.7
5	0.4
8	0.9
9	0.7
13	0.2; 0.7; 0.6
14	2.2
19	3.0; 1.0
20	1.9
21	0.3
22	1.6
23	1.4
24	2.2; 3.2
25	2.2; 3.2
26	2.2; 3.2
27	Not Determined
28	Not Determined
29	Not Determined
30	1.3; 3.6; 2.3
31	1.3; 3.6; 2.3
32	1.3; 3.6; 2.3
33	0.5
34	0.5
35	2.3; 2.9; 2.7

[1]Stations 1, 2, 6, 7, 10, 11, 12, and 15-18 were dry, frozen solid, or inaccessible due to snow accumulation at the time of sampling.

2.4.11. Statistical Methods

The preliminary statistical plan for phytoplankton, zooplankton, periphyton, benthos, water chemistry and physical characteristics includes statistical and graphic descriptions of spatial and temporal variation.

A. Biological Data

Diversity indices are computed to give a numerical approximation of the complexity or diversity of the community being sampled. The importance of diversity indices lies in the fact that low diversity is frequently associated with polluted or stressed communities whereas high diversity is often associated with stable communities.

Diversity indices measure the structure of biological communities to facilitate comparisons between communities and to monitor communities across time. One measure of community structure is the number of species present. This number is used in two ways: as a simple count of the species present and in relation to the number of individuals present (Richness Index, Dahlberg and Odum 1970). Another measure of diversity is the distribution of individuals among the species (Evenness Index, Pielou 1969). A fourth measure of diversity is the Shannon Index (Pielou 1966), which considers both the Evenness and Richness components of the community's structure.

In addition to species diversity indices, the abundance and percent composition of each species or taxon is calculated, along with the arithmetic mean, standard deviation, variance, sum, range, and coefficient of variation.

B. Physical and Chemical Data

Water chemistry and physical characteristics are analyzed in replicate. Three basic methods are employed in the analyses: 1) calculation of simple (univariate) statistics, 2) linear correlation between variables two at a time to statistically infer relationships, 3) analyses of variance to statistically examine the average response levels and their effects across the sampling area chosen.

The simple statistics assist in evaluating actual or implied response changes in the aquatic ecosystem. The simple statistics used are primarily measures of central tendency and dispersion. A measure of central tendency is the arithmetic mean, which measures the average value of the sampled characteristic. The standard deviation, variance, and range are measures of dispersion and are used as estimates of spread of the characteristics sampled. The coefficient of variation, expressed as a percentage of the mean, measures the amount of variation in the sample for a given characteristic.

Graphic plots are drawn for each location across time. These three-dimensional plots show time as one dimension and chemical or physical characteristics as the other two dimensions. These plots are drawn to identify possible interactions across time.

A product-moment correlation coefficient is computed for each pair of numeric variables. Its value, along with the probability that the absolute value of the computed correlation coefficient being greater than zero by chance for a specific sample size, is printed [i.e., Prob ($|r|>0|$ rho=0)].

The correlation coefficient measures the degree of association on an absolute scale between -1 and +1 with 0 indicating no statistical association. A positive (negative) value between 0 and +1 (-1) indicates a tendency of one variable to increase (decrease) as the other increases.

The correlation coefficient makes no statement as to the reality or causality of an association. It may verify the existence of a causal association, but is not itself proof of a relationship. The reality of cause and effect can be inferred only from ecological knowledge and an understanding of the dynamics of the ecosystem.

The analyses of variance tables are presented with the summary calculations necessary to statistically determine whether the differences in sample means for the constituents under study are greater than expected by chance. These tables will be constructed after a preliminary examination of the data in order to evaluate and construct hypotheses for testing. Tables will include the degrees of freedom, sum of squares, and mean square for each source of variation in the specified model. Following the analyses of variance, appropriate multiple comparison tests for either equal replicates or unequal replicates will be performed to assess sampling differences

C. Interrelationships

To assess interrelationships between the biological, water chemistry and physical characteristics, three-dimensional plots with sampling period (time) on one axis and a selective list of water chemistry, physical and biological characteristics on the other two dimensions will be constructed. From these plots, statements about trends and synergistic pairs of characteristics will be made. In the future, correlations between the biological and chemistry data will be provided in annual and final reports to assist in interpreting the three-dimensional plots.

2.4.12. References

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2.5. Other Studies

2.5. OTHER ENVIRONMENTAL STUDIES PROGRAMS

2.5.1 SOILS SURVEY AND PRODUCTIVITY ASSESSMENT STUDIES

2.5.1.1 Objectives

The soils surveys are designed to fulfill the requirements of the oil shale lease, provide data necessary in the determination of ecosystem relationships and to provide information required during revegetation studies.

Samples collected for the plant-soil relationship will be analyzed for textural classification, available plant nutrients, pH, cation exchange capacity, salinity and lime percentage. These parameters and properties will provide data which are relevant to the climatic and edaphic condition in the leased area. Selected samples will be analyzed for trace metals by element scan.

The soils study and analysis should be completed by the end of November 1975. All information gathered from this program will be included in the final DDP.

2.5.1.3 Results

The soils survey and study program outlined above will fulfill all lease requirements and associated stipulations. In addition, the soils program will define the relationships between vegetative types and soil environment to determine the suitability of these soils for future revegetation purposes. The relationships obtained will determine which of the native plants can tolerate the soil environment which is available and will aid in the determination of the proper species composition for a future revegetative community.

2.5.2 ARCHAEOLOGICAL SURVEY

2.5.2.1 Objectives

An archaeological survey will be performed on the leased area to determine the location of any existing areas of historic and scientific interest as specified by the oil shale lease. This study will be completed prior to the development of any of the leased areas.

2.5.2.2 Methods

Prior to the disturbance of any lands, during the exploratory portion of the environmental programs, an archaeological survey has been completed. These initial surveys were conducted by Dr. Alan Olson, University of Denver, and Dr. Calvin H. Jennings, Colorado State University, on areas such as drill pads, shallow water monitoring holes, hydrology stations, fenceline construction for vegetation exclosures, new roads and any other disturbance areas which were surveyed.

During the summer of 1975, an intensive archaeological survey will be conducted on the site and surrounding areas. If significant artifacts are located, they will be removed for further study.

An inventory will be made to identify cultural resources that may qualify for the National Register of Historic Places. This inventory would identify the prehistoric and historic sites on the leased area and surrounding areas, and would include collections, descriptions and identification of any area which produced cultural material. These collections and records would be stored and made available to any interested parties.

A literature survey will be performed which will include an examination of collections which are pertinent to the leased area. This would include any prior archaeological studies of the area. All information will be abstracted and collated to correlate this with field information in order to provide a complete study of the cultural sites of the leased area and surrounding planned disposal areas.

The archaeological contractor will report the results of his survey to the Area Oil Shale Supervisor.

The overall results and findings of this program will be included in the Detailed Development Plan. The archaeological survey will begin in June of 1975 and will be completed sometime during the month of September 1975.

2.5.2.3 Results

Field surveys of disturbed areas have been completed except for the deep and shallow water monitoring stations and hydrology stations planned for the 84 Mesa area in the future.

No significant archaeological finds were made during these surveys. Archaeological clearance sheets are included.

FROM: Glover, Fr
Vice Pres. of Research
Thorne Ecological Inst.
Boulder, Colo. 80302

12/18

S- 59064 A

DATE REPLY DUE: 1/01/74

For Dir. Sign.

CC: Reid Stone

RFRD: LLM

DATE: 12/20/73

SUBJECT: ltr. from Fred Glover, re archeological finds, that have been discovered within impending oil shale leasing areas in Colorado.
Jacobs:X5401

ACK'D BY AND DATE:

SIGNED BY AND DATE:

FILE:

1-102
(JUNE 1971)

U.S. GOVERNMENT PRINTING OFFICE: 1973

arch

THORNE
ECOLOGICAL
INSTITUTE

2305 CANYON BLVD. BOULDER, COLORADO 80302 (303) 443-732

Secretary of the Interior
U.S. Department of the
Office of the Secretary
Washington, D.C. 20240

December 18, 1973

Honorable Secretary:

The attached report has just come to my attention and its implications may warrant serious consideration due to the impending oil shale leasing program in Colorado.

The Ca tract and its utility corridor is the specific area of concern right now. A decision needs to be reached regarding desirable action to be taken for salvage operations of the archeological values of the Ca tract. Any time schedule for salvage operations should consider the delays that may be inherent due to our winter conditions.

We would appreciate maintaining contact and if we can be of further assistance, please call me; my home phone is: Ft. Collins, Colorado 303/484-4122.

Sincerely,

Fred Glover

Fred Glover
Vice President of Research

FG:cl

cc: Mr. Ten Eyck, Colo. Dept. Nat. Res.
Mr. Dale Andrus, State Director, BLM

1101 West Oak Street
Fort Collins, Colorado 80521
December 11, 1973

Dr. Fred Glover, Vice-President
Thorne Ecological Institute
2305 Canyon Boulevard
Boulder, Colorado 80302

Dear Fred:

Judging from accounts of the rapidity with which the Oil Shale Prototype Leasing Program is being implemented, I think it is appropriate to advise you, informally, of the results of last summer's archaeological reconnaissance in the Piceance Basin and ask that you assist in preparing a salvage program for the area.

In a non-stratified random sample of the Yellow Creek drainage and a traditional reconnaissance of the Ca and Cb Lease Tracts and the Douglas Creek shale dumps, we recorded 94 historic and prehistoric archaeological sites. As the enclosed table shows, 11 of these sites are within the boundaries of the Ca tract and several others are along the access, power and water corridors, as well as associated with spent shale dump areas. No sites were found in the Cb tract.

It is impossible to give a statement on the scientific value of each endangered site as our analysis of last summer's data is not complete as yet. However, as my report on our present knowledge of the Piceance Basin's cultural resources shows, we actually know very little about the region's history and how man has fit it into his adaptation over the past 4,000 years. Consequently, any damage to sites in the area has a high potential for seriously impairing our knowledge of the basin's prehistoric and more recent occupations. Such impairment can be avoided, however, if we can establish a coherent program of scientific study before actual development begins. The historical/cultural component of the Regional Oil Shale Study is a step in that direction, but only a first step.

The benefits to science from early organization are obvious. However, it should also be pointed out that organization of an archaeological salvage plan now will also aid the lessees and involved Federal agencies in meeting the requirements of the Antiquities Act of 1906 (Public Law 59-209; 34 Stat. 225; 16 U.S.C. 431-433) and other pertinent legislation.

There is no doubt that leases will be made well before I can complete the impact statement for the cultural resources of the basin. If

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we wait until that report is finished, it is likely that sites will be damaged or destroyed and knowledge lost. I hope you can help by bringing the matter to the attention of the appropriate parties and then directing them to me or to some other qualified archaeologist for further information.

Thank you,

Cal

Calvin H. Jennings

CHJ/sj

cc: Don Bruns, BLM, Craig
H. D. Burke

DISTRIBUTION OF RECORDED ARCHAEOLOGICAL SITES BY IMPACT AREA OR TYPE*

Ca Tract	Shale Dumps	Access Corridors	Utility Corridors
5-RB-6	5-RB-1	5-RB-43	5-RB-46
5-RB-7	5-RB-17	5-RB-46	5-RB-69
5-RB-8	5-RB-78	5-RB-47	5-RB-94
5-RB-9	5-RB-79	5-RB-48	
5-RB-10	5-RB-80	5-RB-76	
5-RB-11	5-RB-81		
5-RB-12	5-RB-82		
5-RB-13	5-RB-83		
5-RB-16	5-RB-84		
5-RB-20	5-RB-85		
5-RB-23	5-RB-86		
	5-RB-87		
	5-RB-88		
	5-RB-89		
	5-RB-90		
	5-RB-91		
	5-RB-92		

*Assignment of sites to access and utility corridors is tentative. The final statement will have to await the availability of better locational data on these corridors than is presently on hand.

Piceance Basin Oil Shale

Piceance Basin

Form 6230-2
(June 1968)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ANTIQUITIES SITE INVENTORY

☒ Archeological ☐ Paleontological ☐ Historical

1. Site number	2. Type of site
AR-05-010-~~151~~ 245	Open chipping

3. State	County	District	4. Map reference
Colorado	Rio Blanco	Craig	Wolf Ridge 7½ min

5. Location

3½ miles west of the 84 Ranch on the east end of a ridge between Corral Gulch and Box Elder Gulch

Preliminary site report; final site report in preparation at Colorado State University, Ft. Collins, Colorado.

Section	Township	Range	Meridian
34 NE¼ of SE¼	1 South	99 West	6th PM

6. Land ownership status	7. Other site designations
Pueblic domain	5 RB-6

8. Cultural affiliation; Geologic Age and/or formation; dates of use

9. Site description, position, surrounding terrain, and importance

Flakes and finishing chips in and around several ant hills. No fire pits or other features visible on this site. Pinyon-juniper, sage, cactus, grasses on low ranging. East northeast extension of ridge 100 meters above upper perimeter of Garden Gulch member 6750 ft.

10. Area of occupation	11. Present condition
20m x 75 m	Excelent
12. Photo numbers	
none	

13. Informants and references

Robert H. Hurlbutt
Colorado State University
6-17-73

14. Recorded by	Date
Daniel J. Hutchison	February 7, 1974

(continued on reverse)

15. Sketch and/or remarks

EVALUATION

16. Does site have recreation value? ☐ Yes ☒ No If "yes," has the Recreation Inventory Form 6110–3 been completed? ☐ Yes ☐ No

17. Does site have sufficient value to justify preservation and/or development? ☐ Yes ☒ No If "yes," specify type of preservation or development.

This site has been evaluated and a determination was made that it is not of National Register significance. The only value this site has is in the material which would be salvaged before any mining operation. The salvage and removal of all the prehistoric cultural material by a qualified archeologist will greatly increase the value of this site, but the site does not warrent preservation after the salvage excavations have preserved the scientific data.

Daniel J. Hutchison
Feb 8 1974

18. Reviewed by *(Signature of District Manager)* | Date

Form 6230-2
(June 1968)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ANTIQUITIES SITE INVENTORY

[xx] Archeological [ ] Paleontological [ ] Historical

1. Site number	2. Type of site
AR-05-010-~~159~~ 246	open chipping

3. State	County	District	4. Map reference
Colorado	Rio Blanco	Craig	Wolf Ridge 7½ min

5. Location

4 miles west on dirt road from 84 Ranch up Corral Gulch ½ mile southwest along top of the ridge. Site on south side of road.

Preliminary Site Report ~~and~~ Final Site Report in preparation at Colorado State University, Ft. Collins, Colorado.

Section	Township	Range	Meridian
34 sw¼ sw¼	1 south	99 west	6th PM

6. Land ownership status	7. Other site designations
Public domain	5 RB-7

8. Cultural affiliation; Geologic Age and/or formation; dates of use

Public domain

9. Site description, position, surrounding terrain, and importance

Thin scatter of flakes in small clearing on ridge. Retouched flakes in ant hills. No signs of more intensive use such as fire pits. Ridge top on divide between Corral and Box Elder Gulches about 50 meters south of road. Vegetation, pinyon and juniper, grasses. Site has excellent view of Box Elder Gulch but none of Corral Gulch. Southern Exposure. 6990 feet elevation. Water in Box Elder Gulch.

10. Area of occupation	11. Present condition
30 meters in diameter	excellent
12. Photo numbers	
yes at CSU	

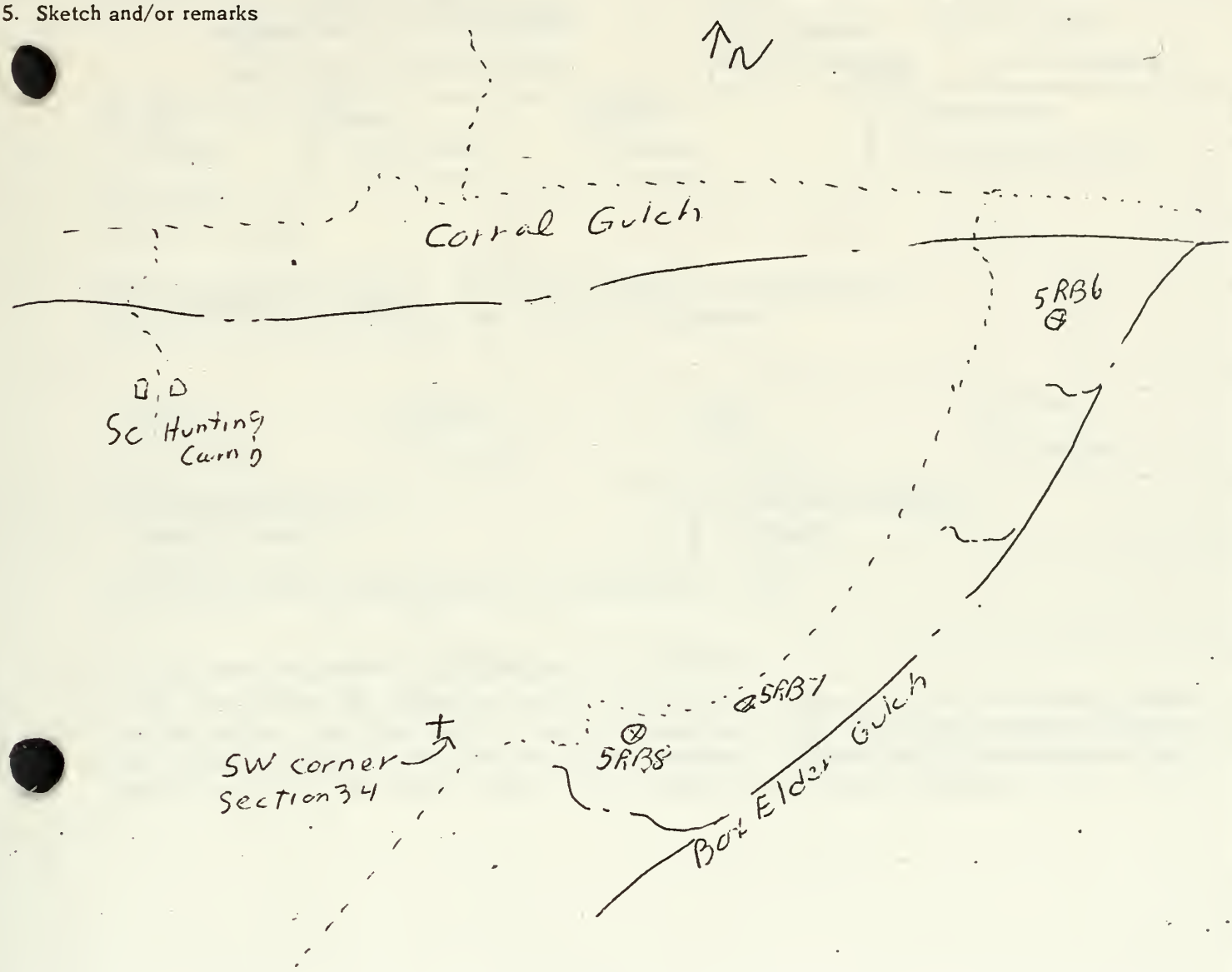
13. Informants and references

Dr. C. H. Jennings
Colorado State University
6-17-73

14. Recorded by	Date
Daniel J. Hutchison	February 7, 1974

(continued on reverse)

15. Sketch and/or remarks



EVALUATION

16. Does site have recreation value? ☐ Yes ☒ No If "yes," has the Recreation Inventory Form 6110–3 been completed? ☐ Yes ☐ No

17. Does site have sufficient value to justify preservation and/or development? ☐ Yes ☒ No If "yes," specify type of preservation or development.

This site has been evaluated and a determination was made that it is not of National Register significance. The only value this site has is in the material which would be salvaged before any mining operation. The salvage and removal of all the prehistoric cultural material by a qualified archeologist will greatly increase the value of this site, but the site does not warrent preservation after the salvage excavations have preserved the scientific data.

Daniel J. Patterson

18. Reviewed by *(Signature of District Manager)* | Date

Form 6230-2
(June 1968)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ANTIQUITIES SITE INVENTORY

[X] Archeological [ ] Paleontological [ ] Historical

1. Site number	2. Type of site
AR-05-010-~~150~~ 347	Open chipping

3. State	County	District	4. Map reference
Colorado	Rio Blanco	Craig	Wolf Ridge 7½ min

5. Location

West of 5 RB-7

Preliminary Site Report; Final Site Report in preparation at Colorado S ate University, Ft. Collins, Colorado.

Section	Township	Range	Meridian
34 SW¼ SW¼	1 South	99 West	6th PM

6. Land ownership status	7. Other site designations
Public domain	5 RB-8

8. Cultural affiliation; Geologic Age and/or formation; dates of use

9. Site description, position, surrounding terrain, and importance

Thin scattering of flakes in small clearing in pinyon-juniper retouching flakes in ant hills. No fire pits or other features. Site is on the highest part of the ridge between Corral and Box elder Gulchs. Exposed in all directions but vest view is of Box Elder Gulch to the south. 7000 feet elevation.

10. Area of occupation	11. Present condition
30 meters in diameter	Excellent
12. Photo numbers	
Yes CSU	

13. Informants and references

C. H. Jennings
Colorado State Universtty
6-17-73

14. Recorded by	Date
Daniel J. Hutchison	February 7, 1974

(continued on reverse)

15. Sketch and/or remarks

EVALUATION

16. Does site have recreation value? ☐ Yes xxx No If "yes," has the Recreation Inventory Form 6110–3 been completed? ☐ Yes ☐ No

17. Does site have sufficient value to justify preservation and/or development? ☐ Yes xx No If "yes," specify type of preservation or development.

This site has been evaluated and a determination was made that it is not of National Register significance. The only value this site has is in the material which would be salvaged before any mining operation. The salvage and removal of all the prehistoric cultural material by a qualified archeologist will greatly increase the value of this site, but the site does not warrent preservation after the salvage excavations have preserved the scientific data.

Daniel J. Hutchison

18. Reviewed by *(Signature of District Manager)* | Date

Form 6230-2
(June 1968)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ANTIQUITIES SITE INVENTORY

[xx] Archeological [ ] Paleontological [ ] Historical

1. Site number	2. Type of site
AR-05-010-~~154~~ 248	open chipping

3. State	County	District	4. Map reference
Colorado	Rio Blanco	Craig	Wolf Ridge

5. Location

Preliminary Site Report; Final Site Report in preparation at Colorado State University, Ft. Collins, Colorado.

Section	Township	Range	Meridian
34 SE¼ NE¼	1 South	99 west	6th PM

6. Land ownership status	7. Other site designations
Public domain	5 RB 9

8. Cultural affiliation; Geologic Age and/or formation; dates of use

9. Site description, position, surrounding terrain, and importance

Concentration of flakes in 10 meter diameter area. Apparently eroding out of brown sandy layer over gray shale. One projectile point and one possible fire pit. Near top of ridge facing east. 6680 foot elevation. Some depth to the site - possibly 50 to 50 cm deep.

10. Area of occupation	11. Present condition
15 m x 15 m	excellent
12. Photo numbers	
2 CSU	

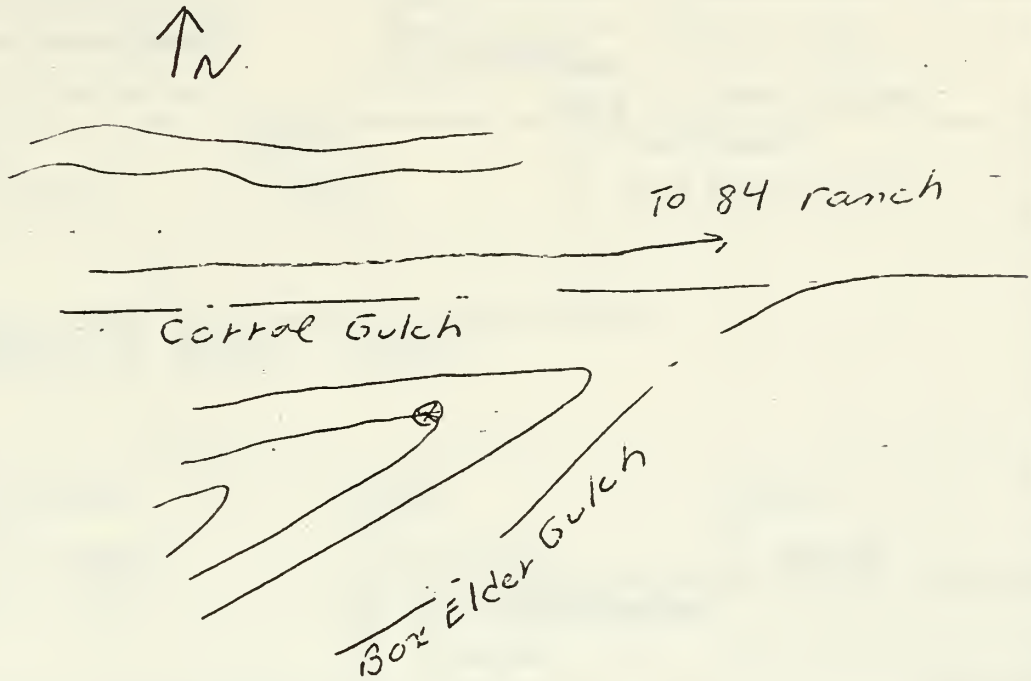
13. Informants and references

Matthew Freedman
Colorado State University
June 17, 1973

14. Recorded by	Date
Daniel J. Hutchison	February 7, 1974

(continued on reverse)

15. Sketch and/or remarks



EVALUATION

16. Does site have recreation value? ☐ Yes ☒ No If "yes," has the Recreation Inventory Form 6110–3 been completed? ☐ Yes ☐ No

17. Does site have sufficient value to justify preservation and/or development? ☐ Yes ☒ No If "yes," specify type of preservation or development.

This site has been evaluated and a determination was made that it is not of National Register significance. The only value this site has is in the material which would be salvaged before any mining operation. The salvage and removal of all the prehistoric cultural material by a qualified archeologist will greatly increase the value of this site, but the site does not warrent preservation after the salvage excavations have preserved the scientific data

Dane J. Hutchison

Reviewed by *(Signature of District Manager)*	Date

Form 6230-2
(June 1968)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ANTIQUITIES SITE INVENTORY

[xx] Archeological [ ] Paleontological [ ] Historical

1. Site number	2. Type of site
AR-05-010-~~155~~ 249	Open chipping

3. State	County	District	4. Map reference
Colorado	Rio Blanco	Craig	Wolf Ridge 7½ min

5. Location

Preliminary Site Report; Final Site Report in preparation at Colorado State University, Ft. Collins, Colorado.

Section	Township	Range	Meridian
10 NE¼ SW¼	2 south	99 west	6th pm

6. Land ownership status	7. Other site designations
Public domain	5 RB 10

8. Cultural affiliation; Geologic Age and/or formation; dates of use

9. Site description, position, surrounding terrain, and importance

Open ridge top on crest of first ridge north of Stake Springs Draw. Site in the pinyon-juniper tree line adjoining a large sage opening. 7180 feet elevation

10. Area of occupation	11. Present condition
75 meter diameter	excellent
12. Photo numbers	
yes CSU	

13. Informants and references

Robert E. Hurlbutt
Colorado State University

14. Recorded by	Date
Daniel J. Hutchison	February 7, 1974

(continued on reverse)

15. Sketch and/or remarks

EVALUATION

16. Does site have recreation value? ☐ Yes ☒ No If "yes," has the Recreation Inventory Form 6110–3 been completed? ☐ Yes ☐ No

17. Does site have sufficient value to justify preservation and/or development? ☐ Yes ☒ No If "yes," specify type of preservation or development.

This site has been evaluated and a determination was made that it is not of National Register significance. The only value this site has is in the material which would be salvaged before any mining operation. The salvage and removal of all the prehistoric cultural material by a qualified archeologist will greatly increase the value of this site, but the site does not warrent preservation after the salvage excavations have preserved the scientific data.

Daniel J. Hutchison

18. Reviewed by *(Signature of District Manager)* | Date

Form 6230-2
(June 1968)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ANTIQUITIES SITE INVENTORY

[xx] Archeological [ ] Paleontological [ ] Historical

1. Site number	2. Type of site
AR-05-010-~~156~~ 330	open chipping

3. State	County	District	4. Map reference
Colorado	Rio Blanco	Craig	Wolf Ridge 7½ min

5. Location

Preliminary site report; Final site report in preparation at Colorado State University, Ft. Collins, Colorado.

Section	Township	Range	Meridian
10 SW¼ NE¼	2 south	99 W	6th PM

6. Land ownership status	7. Other site designations
Public domain	5 RB-11

8. Cultural affiliation; Geologic Age and/or formation; dates of use

9. Site description, position, surrounding terrain, and importance

Scattered flakes and one point on ridge top. Old road cuts through the site. Elevation 7140 feet. Sage, small pinyon and juniper. Charcoal, dead larger pinyon.

10. Area of occupation	11. Present condition
30 meters in diameter	good
12. Photo numbers	
yes CSU	

13. Informants and references

Cathy Holder
Colorado State University
6-18-74

14. Recorded by	Date
Daniel J. Hutchison	February 7, 1974

(continued on reverse)

15. Sketch and/or remarks

EVALUATION

16. Does site have recreation value? ☐ Yes ☒ No If "yes," has the Recreation Inventory Form 6110–3 been completed? ☐ Yes ☐ No

17. Does site have sufficient value to justify preservation and/or development? ☐ Yes ☒ No If "yes," specify type of preservation or development.

This site has been evaluated and a determination was made that it is not of National Register significance. The only value this site has is in the material which would be salvaged before any mining operation. The salvage and removal of all the prehistoric cultural material by a qualified archeologist will greatly increase the value of this site, but the site does not warrent preservation after the salvage excavations have preserviced the scientific data.

Daniel J. Hutchison

18. Reviewed by *(Signature of District Manager)*	Date

Form 6230-2
(June 1968)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ANTIQUITIES SITE INVENTORY

[xx] Archeological [ ] Paleontological [ ] Historical

1. Site number	2. Type of site
AR-05-010-~~157~~ 381	open chipping

3. State	County	District	4. Map reference
Colorado	Rio Blanco	Craig	Wolf Ridge 7½ min

5. Location

Preliminary Site Report; Final Site Report in preparation at Colorado State University, Ft. Collins, Colorado.

Section	Township	Range	Meridian
10 SE¼ NE¼	2 south	99 west	6th PM

6. Land ownership status	7. Other site designations
public domain	5 RB-12

8. Cultural affiliation; Geologic Age and/or formation; dates of use

9. Site description, position, surrounding terrain, and importance

On south slope on a small north south ridge - perpindicular to Box Elder. Knife and many flakes recovered. Elevation 7060. Pinyon, juniper, sagebrush.

10. Area of occupation	11. Present condition
10 meters	good
12. Photo numbers	
yes CSU	

13. Informants and references

Rebecca A. Gilbert
Colorado State University

14. Recorded by	Date
Daniel J. Hutchison	February 7, 1974

(continued on reverse)

15. Sketch and/or remarks

EVALUATION

16. Does site have recreation value? ☐ Yes ☒ No If "yes," has the Recreation Inventory Form 6110–3 been completed? ☐ Yes ☐ No

17. Does site have sufficient value to justify preservation and/or development? ☐ Yes ☒ No If "yes," specify type of preservation or development.

This site has been evaluated and a determination was made that it is not of National Register significance. The only value this site has is in the material which would be salvaged before any mining operation. The salvage and removal of all the prehistoric cultural material by a qualified archeologist will greatly increase the value of this site, but the site does not warrent preservation after the salvage excavations have preserved the scientific data.

Daniel J Hutchison

Reviewed by *(Signature of District Manager)*	Date

Form 6230-2
(June 1968)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ANTIQUITIES SITE INVENTORY

[XX] Archeological [ ] Paleontological [ ] Historical

1. Site number	2. Type of site
AR-05-010-~~158~~ 252	open camp

3. State	County	District	4. Map reference
Colorado	Rio Blanco	Craig	Wolf Ridge 7½ min

5. Location

Preliminary site report; final site report in preparation at Colorado State University, Ft. Collins, Colorado.

Section	Township	Range	Meridian
10 SW¼ NE¼	2 south	99 west	6 th pm

6. Land ownership status	7. Other site designations
Public domain	5 RB-13

8. Cultural affiliation; Geologic Age and/or formation; dates of use

9. Site description, position, surrounding terrain, and importance

Site on open top of first ridge north of stake Springs Draw. Site is 15 in the pinyon-juniper tree line adjoining a large sage opening. Several fire pits with flakes on top of fire area. Best preserved site in the CA tract. This site should be studied intensively. Test drilling was planned for an area 50 feet from the site in the summer of 1973. Elevation 7120 feet.

10. Area of occupation	11. Present condition
75 meters	excellent
12. Photo numbers	
yes 1973 CSU	

13. Informants and references

Colorado State University
June 18, 1973

14. Recorded by	Date
Daniel J. Hutchison	February 7, 1974

(continued on reverse)

15. Sketch and/or remarks

EVALUATION

16. Does site have recreation value? ☐ Yes ☒ No If "yes," has the Recreation Inventory Form 6110–3 been completed? ☐ Yes ☐ No

17. Does site have sufficient value to justify preservation and/or development? ☐ Yes ☒ No If "yes," specify type of preservation or development.

This site has been evaluated and a determination was made that it is not of National Register significance. The only value this site has is in the material which would be salvaged before any mining operation. The salvage and removal of all the prehistoric cultural material by a qualified archeologist will greatly increase the value of this site, but the site does not warrent preservation after the salvage excavations have preserved the scientific data.

Donald J. Hunt Chairman

Reviewed by *(Signature of District Manager)*	Date

Form 6230-2
(June 1968)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ANTIQUITIES SITE INVENTORY

[xx] Archeological [ ] Paleontological [ ] Historical

1. Site number	2. Type of site
AR-05-010-~~159~~ 253	open camp

3. State	County	District	4. Map reference
Colorado	Rio Blanco	Craig	Wolf Ridge 7½ min

5. Location

Preliminary Site Report; Final Site Report in preparation at Colorado State University, Ft. Collins, Colorado.

Section	Township	Range	Meridian
10 NE¼ NE¼	2 south	99 west	6th PM

6. Land ownership status	7. Other site designations
Public Domain	5 RB-14

8. Cultural affiliation; Geologic Age and/or formation; dates of use

9. Site description, position, surrounding terrain, and importance

Ridge top with heavy concentration of flakes scattered around the area. Many dead trees, evidence of fire. Pinyon-juniper, sage, grasses. 7120 foot elevation.

10. Area of occupation	11. Present condition
60 meters in diameter	
12. Photo numbers	
yes CSU 1973	

13. Informants and references

Colorado State University
June 18, 1973

14. Recorded by	Date
Daniel J. Hutchison	February 7, 1973

(continued on reverse)

15. Sketch and/or remarks

EVALUATION

16. Does site have recreation value? ☐ Yes ☒ No If "yes," has the Recreation Inventory Form 6110–3 been completed? ☐ Yes ☐ No

17. Does site have sufficient value to justify preservation and/or development? ☐ Yes ☒ No If "yes," specify type of preservation or development.

This site has been evaluated and a determination was made that it is not of National Register significance. The only value this site has is in the material which would be salvaged before any mining operation. The salvage and removal of all the prehistoric cultural material by a qualifieid archeologist will greatly increase the value of this site, but the site does not warrent preservation after the salvage excavations have preserved the scientific data.

Daniel J Hutchison

18. Reviewed by *(Signature of District Manager)*	Date

Form 6230-2
(June 1968)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ANTIQUITIES SITE INVENTORY

[xx] Archeological [ ] Paleontological [ ] Historical

1. Site number	2. Type of site
AR-05-010-~~160~~ 289	chipping

3. State	County	District	4. Map reference
Colorado	Rio Blanco	Craig	Sagebrush Hills 7½ min

5. Location

Preliminary Site Report; Final Site Report in preparation at Colorado State University, Ft. Collins, Colorado.

Section	Township	Range	Meridian
33, NE¼ NE¼	1 south	99 west	

6. Land ownership status	7. Other site designations
public domain	5 RB 20

8. Cultural affiliation; Geologic Age and/or formation; dates of use

9. Site description, position, surrounding terrain, and importance

A thin scatter of flakes and 1 projectile point on a narrow ridge top with exposure to the south and west. Elevation 7,080 feet.

10. Area of occupation	11. Present condition
½ mile diameter	good
12. Photo numbers	
yes CSU	

13. Informants and references

Colorado State University
June 17, 1973

14. Recorded by	Date
Daniel J. Hutchison	February 7, 1974

(continued on reverse)

15. Sketch and/or remarks

EVALUATION

16. Does site have recreation value? ☐ Yes ☒ No If "yes," has the Recreation Inventory Form 6110–3 been completed? ☐ Yes ☐ No

17. Does site have sufficient value to justify preservation and/or development? ☐ Yes ☒ No If "yes," specify type of preservation or development.

This site has been evaluated and a determination was made that it is not of National Register significance. The only value this site has is in the material which would be salvaged before any mining operation. The salvage and removal of all the prehistoric cultural material by a qualified archeologist will greatly increase the value of this site, but the site does not warrent preservation after the salvage excavations have preserved the scientific data.

Daniel J. Hutchison

18. Reviewed by *(Signature of District Manager)* | Date

Form 6230-2
(June 1968)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ANTIQUITIES SITE INVENTORY

[xx] Archeological [ ] Paleontological [ ] Historical

1. Site number	2. Type of site
AR-05-010-161 262	chipping

3. State	County	District	4. Map reference
Colorado	Rio Blanco	Craig	Sagebrush Hill 7½ min

5. Location

Preliminary Site Report; Final Site Report in preparation at Colorado State University, Ft. Collins, Colorado.

Section	Township	Range	Meridian
33 NE¼ SW¼	1 South	99 west	6th PM

6. Land ownership status	7. Other site designations
Public Domain	5 RB-23

8. Cultural affiliation; Geologic Age and/or formation; dates of use

9. Site description, position, surrounding terrain, and importance

Cultural material found on knoll of a saddle along a ridge crest. Gulches run north and south of the site. Open sagebursh flat with grasses and shrubs. Small runoff areas from hill to the saddle. Indegenous parchute shale. Exposure on east and west. Elevation 6960.

10. Area of occupation	11. Present condition
75 x 30 meters	good
12. Photo numbers	
yes CSU 1973	

13. Informants and references

Colorado State University
June 18, 1973

14. Recorded by	Date
Daniel J. Hutchison	February 7, 1974

(continued on reverse)

15. Sketch and/or remarks

EVALUATION

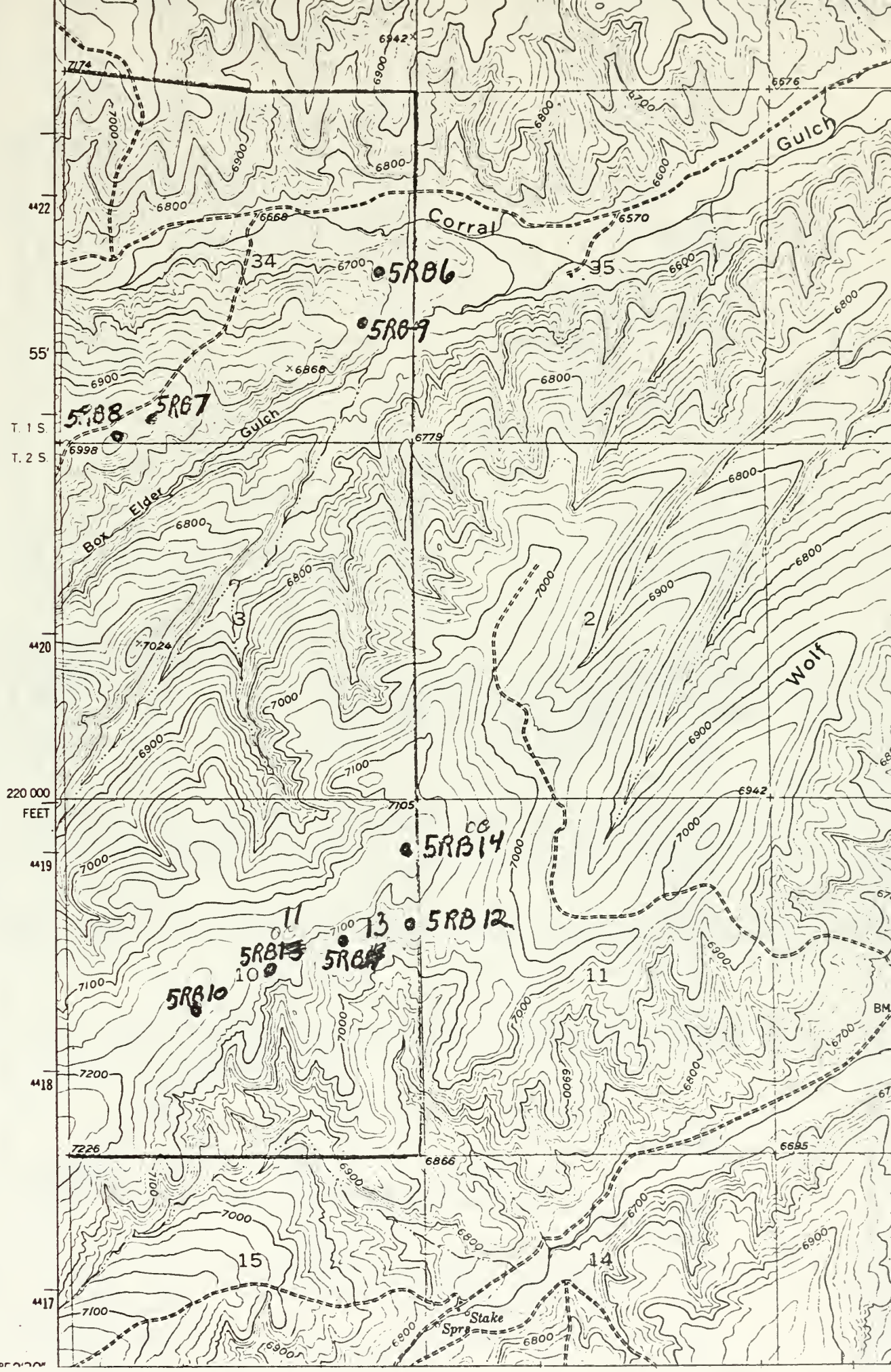
16. Does site have recreation value? ☐ Yes ☒ No If "yes," has the Recreation Inventory Form 6110–3 been completed? ☐ Yes ☐ No

17. Does site have sufficient value to justify preservation and/or development? ☐ Yes ☒ No If "yes," specify type of preservation or development.

This site has been evaluated and a determination was made that it is not of National Register significance. The only value this site has is in the material which would be salvaged before any mining operation. The salvage and removal of all the prehistoric cultural material by a qualified archeologist will greatly increase the value of this site, but the site does not warrent preservation after the salvage excavations have preserved the scientific data.

Daniel J. Hutchison

.eviewed by *(Signature of District Manager)*	Date


Corral
Gulch
Box Elder
Gulch
Wolf
Stake
Spr
5RB6
5RB9
5RB8
5RB7
5RB14
5RB12
5RB13
5RB10
T. 1 S.
T. 2 S.
220 000
FEET
4422
4420
4419
4418
4417
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6570
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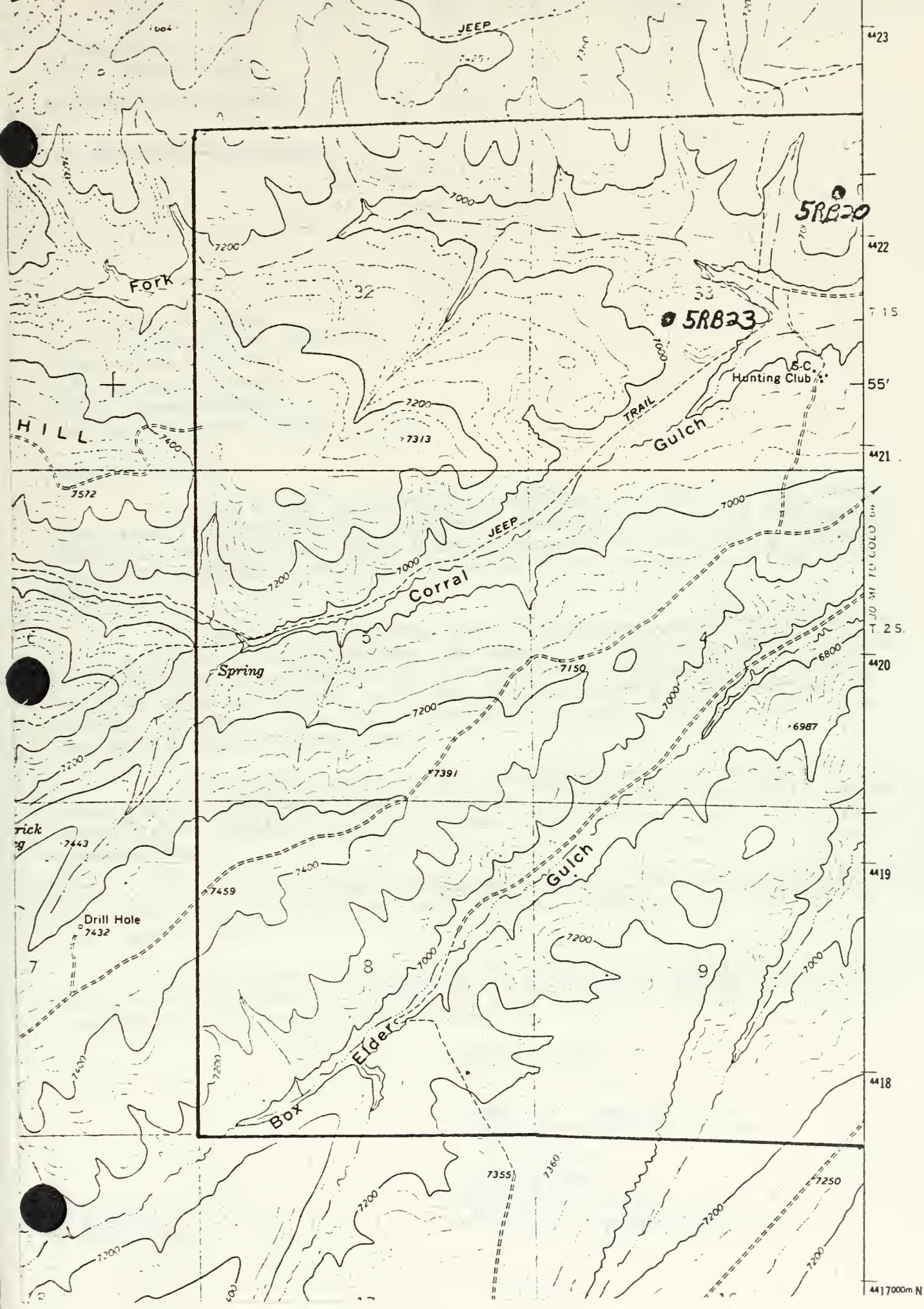
6942
7226
6866
6695

15,995


JEEP
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Gulf Mineral Resources Co.
A Division of Gulf Oil Corporation

Standard Oil Company (Indiana)

Rio Blanco Oil Shale Project

June 27, 1974

Mr. Peter A. Rutledge
Area Oil Shale Mining Supervisor
Conservation Division
U.S. Geological Survey
Denver Federal Center
Lakewood, Colorado 80215

Dear Mr. Rutledge:

Included in the stipulations for approval of a portion of the Tract C-a Exploratory Plan (specifically, Section 5 - Geological Exploration Plan and Section 6.2 - Subsurface Hydrology) is the requirement for biological and archaeological investigations of areas to be disturbed by the lessees' activities on the tract.

This is to inform you that detailed investigations of drill hole sites 6, 7, 8 and 11 have been completed with regard to archaeological and biological resources. The investigators have determined that no archaeological resources would be destroyed, and that no significant or unique flora or fauna would be affected, by work on these sites. Attached is a letter from Dr. Alan P. Olson and David B. Winsor to that effect.

Archaeological and biological examinations of the remaining drill hole sites, as well as proposed access routes, will be completed as expeditiously as possible, and a final report will be submitted to you upon completion of these examinations.

Drill hole site construction and drilling will be limited to sites 6, 7, 8 and 11 until archaeological and biological clearances have been obtained on the remaining sites.

Also attached is a letter to the Tract C-a lessees from the BLM approving Exploration Operations Bond 8063-25-88, in the amount of $20,000, to cover the initiation of exploration work on Tract C-a.

Sincerely yours,

Charles Spielman

C. O. Spielman
Vice President
Oil Shale Resources
Gulf Mineral Resources Co.

COS:rc
Enclosures

COLORADO SEMINARY
UNIVERSITY OF DENVER
UNIVERSITY PARK • DENVER, COLORADO 80210

DEPARTMENT OF ANTHROPOLOGY

June 24, 1974

Mr. Charles Spielman
Vice President, Oil Shale Resources
Gulf Mineral Resources Company

Dear Mr. Spielman:

We have investigated coreholes 6,7,8,and 11, and meteorological stations 1,2,3, and 4. These locations were investigated on a three hundred foot radius for the coreholes, and one hundred foot for the meteorological stations. Nothing was found which will impede the utilization of these sites for the projected drilling and station location. Our recommendation is that no resources would be damaged by these projects.

Sincerely,

Alan P. Olson

Alan P. Olson, Ph.D.
Associate Professor

David B. Winsor

David B. Winsor
Limnetics, Inc.

ENVIRONMENTAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: June 23 74

Site: C-96 & road, Parameters (Area) Surveyed: 500 ft

The subject site has been surveyed for environmental baseline conditions an the findings are as follows:

1. Terrestrial: similar to Air station #3
cocklebur, ragweed & ryegrass

2. Wildlife: indication of rabbits & gray squirrels

3. Aquatic: stream not flowing

Method Used:

1. Terrestrial: surface observations

2. Wildlife:

3. Aquatic:

Recommendations:
proceed with drilling operations

David Winsor

Dave Winsor
Environmental Ecologist

Dr. Alan Olson
Archeologist
Observer

ARCHEOLOGICAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: 7/3-8/74

Site: C7 and 9., Parameters (Area) Surveyed: 300 ft. R.

The subject site has been surveyed and the findings are as follows:

Negative as far as any archaeological material

Method Used:

Surface Survey

Recommendations:

Any construction be allowed.

Alan Nelson

Dave Winsor
Terrestrial Ecologist
Observer

Dr. Alan Olson
Archeologist
Surveyor

ENVIRONMENTAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: June 23

Site: C-7, Parameters (Area) Surveyed:

The subject site has been surveyed for environmental baseline conditions and the findings are as follows:

1. Terrestrial: sagebrush dormant vegetation with needlegrass & wheatgrass

2. Wildlife: rabbits, ground squirrels & signs of deer

3. Aquatic: next to stream which was trickling. do not damn up this stream

Method Used:

1. Terrestrial: Surface observations

2. Wildlife:

3. Aquatic:

Recommendations: proceed with drilling

David Winsor

Dave Winsor
Environmental Ecologist

Dr. Alan Olson
Archeologist
Observer

ENVIRONMENTAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: June 22 1974

Site: C-8, C-9, Parameters (Area) Surveyed: 300ft D

The subject site has been surveyed for environmental baseline conditions and the findings are as follows:

1. Terrestrial: Sagebrush, some P-J

2. Wildlife: rabbit, ground squirrels, rodents

3. Aquatic: —

Method Used:

1. Terrestrial:

2. Wildlife:

3. Aquatic:

Recommendations: Proceed with drilling operations

David Winsor

Dave Winsor
Environmental Ecologist

Dr. Alan Olson
Archeologist
Observer

ENVIRONMENTAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: June 22

Site: Air Quality stations 1,2,3,4, Parameters (Area) Surveyed: 300 Ft diameter

The subject site has been surveyed for environmental baseline conditions and the findings are as follows:

1. Terrestrial: #1 sagebrush, scarlet gila, P-J comm
#2 sagebrush
#3 wheatgrass, rice grass, sagebrush
#4 sagebrush rice grass

2. Wildlife: #1 - rabbit, deer, wildness (unidentified) songbirds
#2 - songbirds rabbits
#3 - rabbits, groundsquirrels; chipmunk, golden mantle gnd. squirrel
#4 - cows, squirrels rabbits

3. Aquatic: #3 next to running stream however placement of met. tower should be no problem

Method Used:

1. Terrestrial: SURFACE Observations

2. Wildlife:

3. Aquatic:

Recommendations: proceed with drilling

David Winsor

Dave Winsor
Environmental Ecologist

Dr. Alan Olson
Archeologist
Observer

July 22, 1974

Memorandum

To: Marvin W. Pearson, District Manager, BLM, Craig, CO 81625
Stanley G. Colby, Area Manager, BLM, Meeker, CO 81641

From: Area Oil Shale Supervisor

Subject: Archeological/biological clearances

Attached are the clearances received to date for C-a and C-b. The C-a clearance includes the air quality/meteorology sites and the trailer site in sec. 4.

With regard to drill hole C-10 on C-a which is in the wild horse area, Charles Spielman conferred with Bill Lawhorn (BLM wildlife) who advised there was no need to move the hole. Unless I hear differently from you I will not require the lessees to move the hole.

Additional clearances on C-b are expected shortly to facilitate approval of the rest of their plan.

Peter A. Rutledge

Attachments

File copy

PARutledge/ns

LIMNETICS, INC.
environmental consultants

July 16, 1974
D-19

Mr. Peter A. Rutledge
Area Oil Shale Mining Supervisor
Conservation Division
U. S. Geological Survey
Lakewood, CO 80215

Subject: Archaeological and biological clearances of drill hole sites and access roads on Tract C-a.

Dear Mr. Rutledge:

This letter supplements C. Spielman's letter dated June 27, 1974.

Included in the stipulations for approval for a portion of Tract C-a Exploratory Plan, Section 5, Geological Exploration Plan and Section 6.2 - Surface Hydrology, is the requirement for biological and archaeological investigations of areas to be disturbed by the leessees activities on the Tract.

This is to inform you that detailed investigations were made of core hole sites C-2, 3, C-4, 5, C-10, C-11, C-12, C-13, C-7 (new site), C-9 (new site) and the access roads leading to core holes C-11, C-12, and C-13. Additionally, the proposed trailor office area in Section 4, between core holes C-8 and C-9, was also cleared. Each core hole site was cleared within a 300 foot radius of the designated site and each access road was studied within a 30 foot corridor to these respective core holes. Upon completion, the investigators, Dr. Olson, archaeologist and Dave Winsor, ecologist, indicated the general description found at each site and completed the attached forms to provide a more detailed explanation of their findings and their recommendations.

All the proposed sites were cleared from an archaeological and biological standpoint, however, core hole site C-10 and its access road were found to be

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within the home range of a wild horse herd which were visibly observed utilizing this area. Furthermore, sign posts were sighted in this area marking the territory of this herd. It has been recommended to Gulf-Standard, as a result of this finding, that core hole C-10 be moved directly to the east, adjacent to the Tract boundary and in the general vicinity of the existing access road. This is presently being investigated and when the relocation of this core hole becomes a reality, you will be notified.

The remaining core holes and shallow drill wells located on Tract C-a will be investigated by this same team on July 19 through the 21st. Their findings will be reported to you during the section ending July 27.

Sincerely,

LIMNETICS, INC.

Donald R. Millert

Donald R. Millert,
Project Manager

DRM/bjs

cc: C. Spielman
Dr. Schwendinger
Dr. Harmsworth
Dr. Olson

July 10, 1974
D-8

Mr. Charles Spielman
Vice President - Oil Shale Resources
Gulf Mineral Resources Company
1780 S. Ballaire
Denver, Colorado 80222

Dear Mr. Spielman:

In accordance with the lease agreement, all prospective core hole sites and access roads to the proposed sites must be cleared from a biological and archaeological standpoint. This clearing is to insure that no unique biological communities or archaeological ruins are present in the proposed perturbated area.

During the site visit from July 3 through July 7, eight core hole sites, two access roads and one trailor office area were viewed. Numerically they included core hole sites C 2-3, C4-5, C-10, C-11, C-12, C-13, C-7 (new site), C-9 (new site) and the access road leading to core holes C-11, C-12, and C-13. Additionally, the proposed trailor office area in Section 4 was also cleared. Each core hole site was studied within a 400 foot radius of the designated site and each access road was studied within a 30 foot corridor to its respective core hole. At each site a form was filled out indicating its general description and is attached with this letter to provide a more detailed explanation of its components and our recommendations.

All of the proposed sites were cleared from an archaeological and biological standpoint, however, core hole site C-10 and its access road, needs to be discussed further prior to its biological clearance. This site is located

within the home range of a wild horse herd which were visually observed utilizing this area. Furthermore, sign posts were sighted in this area marking the territory of this herd. Should the access road be cleared as well as the core hole site, this would undoubtedly result in the herd moving to a new area, thus adversely effecting future baseline data accumulation. With this one exception, all of the other sites were cleared biologically for core hole drilling and access road construction.

Sincerely,

David Winsor,
Environmental Ecologist

Dr. Alan Olson,
Archaeologist

DW/bjs

ARCHEOLOGICAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: July 3-8, 1974

Site: Coreholes 233-45, Parameters (Area) Surveyed: 300 Ft. D.

The subject site has been surveyed and the findings are as follows:

~~Negative.~~

Method Used:

Surface Survey

Recommendations:

~~Any necessary operations be allowed.~~

Dave Winsor
Terrestrial Ecologist
Observer

Dr. Alan Olson
Archeologist
Surveyor

ARCHEOLOGICAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: July 3-8, 1974

Site: C 11, 12, 13, plus access roads Parameters (Area) Surveyed: 300Ft D.

The subject site has been surveyed and the findings are as follows:

Site surveyed, with negative results, roadway, also.

Method Used:

Surface survey

Recommendations:

These sites, and the roadway are clear, no problems as far as archeaological material.

Dave Winsor
Terrestrial Ecologist
Observer

Dr. Alan Olson
Archeologist
Surveyor

ENVIRONMENTAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: 7-4-74

Site: C-11 12-13 access road, Parameters (Area) Surveyed: 300 Ft radius of corehole 30 Ft strip for road

The subject site has been surveyed for environmental baseline conditions and the findings are as follows:

1. Terrestrial: presence of P-J (Pinon-Juniper) community as dominant plant with other secondary species such as Opuntia, buckbush, indian paintbrush, scarlet gilia occasional blue spruce

2. Wildlife: evidence of wild horses utilizing this area as well as occasional mule deer. numerous small rodents were observed as well as birds such as morning dove, meadowlark, kingbird, red tail hawk

3. Aquatic: situated on top of ridge - little water present however runoff channels were evident providing water removal during heavy rains as well. Browse good in area

Method Used:

1. Terrestrial: Visual observations. This area is perhaps on the ~~eastern~~ extreme east, ~~west~~ edge of the home range of a group of wild horses. Although sign did not indicate heavy utilization of this area by the herd, the herd was nevertheless observed frequently around 1.5 miles from Air station.

2. Wildlife: This area is heavily utilized by both domestic and wild animals as indicated by the numerous game trails and fecal ~~matt~~ droppings.

3. Aquatic:

Recommendations:

The Pinon-Juniper community that the access road will cut through are ~~an~~ old individuals (75-100 years). When the road is cut extreme caution should be taken to remove as few individual trees as possible. Furthermore with core hole drilling and access road drilling the herd of wild horses that utilize this area will leave due to ~~the~~ human presence and their associated activities.

David B. Winsor

Dave Winsor
Environmental Ecologist

Dr. Alan Olson
Archeologist
Observer

ENVIRONMENTAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: July 5, 1974.

Site: C 2-3, Parameters (Area) Surveyed: _____

The subject site has been surveyed for environmental baseline conditions and the findings are as follows:

1. Terrestrial: This area has already been disturbed by core holing. The vegetation consisted of scattered sagebrush and bucebrush interspersed by grasses and flowers

2. Wildlife: The wildlife observed in this area included, weasals, groundsquirrels, chipmunks. Those noted by their signs were mule deer, rabbits, and an occasional coyote.

3. Aquatic: A creek runs adjacent to this site and it ~~was~~ had water running at the time of this survey. Numerous small mammal tracks were observed along the creek bed indicating utilization of this water supply.

Method Used:

1. Terrestrial: _____

2. Wildlife: _____

3. Aquatic: _____

Recommendations: This area appears to have little drawbacks and drilling and clearing could commence immediately.

David Winsor

Dave Winsor
Environmental Ecologist

Dr. Alan Olson
Archeologist
Observer

ENVIRONMENTAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: July 6, 1974

Site: C-~~2~~3 4-5, Parameters (Area) Surveyed: 400 Ft radius

The subject site has been surveyed for environmental baseline conditions and the findings are as follows:

1. Terrestrial: This area was located in a depression between two ridges and was exclusivley a sagebrush community with interspersed grasses.

2. Wildlife: Little wildlife was observed in this area perhaps the result of its openness. Rabbits and mule deer droppings were noticed however they appeared old

3. Aquatic: Just south of this site is a intermittent stream for runoff control however it is intermittent in nature

Method Used:

1. Terrestrial:

2. Wildlife:

3. Aquatic:

Recommendations:

This areas appears ready for core hole drilling operations from a biological standpoint.

David Winsor

Dave Winsor
Environmental Ecologist

Dr. Alan Olson
Archeologist
Observer

ENVIRONMENTAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: July 6 1974

Site: C-10 - access road, Parameters (Area) Surveyed: Access road 30 ft section to core hole. Core hole 4.5 ft radius

The subject site has been surveyed for environmental baseline conditions and the findings are as follows:

1. Terrestrial: The vegetative community consisted of Pinon-Juniper (very open) with sagebrush meadows. Numerous species of grass (cheat, wheat) and wild flowers were noted (sunflower, cacti)

2. Wildlife: This area is apparently part of the entire home range of a herd of wild horses. Sightings were made of this herd and their marks were evident throughout this area.

3. Aquatic: No ~~permanent~~ permanent streams were noted in this area however intermittent streams were evident for runoff control during heavy rains.

Method Used:

1. Terrestrial: Mule deer droppings were noted as well as rabbits feces. Furthermore, a golden eagle was sighted soaring in this vicinity. Other songsbirds were seen such as the mountain bluebird, magpies, and morning doves.

2. Wildlife:

3. Aquatic:

Recommendations: Since the purpose of this initial two year is to accumulate baseline data on Tract C-a it is imperative that the natural condition of the area be disturbed as little as possible therefore it would be advisable not to disturb this area if plans can be altered. ~~Should~~ If this area must be drilled then baseline data accumulation on the wild horse status in this area will be difficult to ascertain.

David Winsor

Dave Winsor
Environmental Ecologist

Dr. Alan Olson
Archeologist
Observer

LIMNETICS, INC.
environmental consultants

August 1, 1974
D-33

Mr. Peter Rutledge
U. S. Geological Survey
Conservation Division
7200 W. Alameda
Lakewood, Colorado 80226

Dear Mr. Rutledge:

This letter is to inform you of the biological and archaeological clearing of core holes C-1, C-14, C-15 and access roads leading to core holes C-1, C-14, C-15 and C-10. These sites were surveyed by Dr. Alan Olson, Ms. Barbara Thiaville, and David Winsor between July 19 - 23, 1974.

The basic procedure for core hole clearing involved intensively walking a 400-foot radius of the designated site looking for the presence of unique or endangered flora or faunal communities. Also, emphasis is placed on describing the area generally from a vegetative and zoological aspect. Any signs such as game paths, scats or other identifiable material is recorded.

Archaeologically, the core holes and access roads were scoured for remances of pottery or tools indicating the area might have been inhabitated some time in the past. Presently, no artifacts have been found at any of the core hole sites examined.

Should you have any question about our procedure or our findings, please contact me at your convenience.

Sincerely,

David Winsor

David Winsor,
Terrestrial Ecologist

DW/bjs
cc: Dr. R. Harmsworth

RECEIVED
AUG 2 1974
CONSERVATION
CENTRAL REGION

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ARCHEOLOGICAL SURVEY ON

GULF-STACKING IMPACT C-8

Date of Survey: JULY 20, 1974

Site: CH 1, Parameters (Area) Surveyed: 300' R

The subject site has been surveyed and the findings are as follows:

ARCHAEOLOGICALLY NEGATIVE.

Method Used:

SURFACE SURVEY.

Recommendations:

PROCEED WITH PLANNED DRILLING.

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

ARCHEOLOGICAL SURVEY ON

GULF-STANDARD IMPACT C-a

Date of Survey: JULY 20, 1974

Site: NEW CH 10 , Parameters (Area) Surveyed: 300' ~~B~~ R
ROAD 35'

The subject site has been surveyed and the findings are as follows:

NO ARCHAEOLOGICAL MATERIAL ON SITE OR ALONG ACCESS ROAD.

Method Used:

SURFACE SURVEY

Recommendations:

SITE BE CLEARED FOR CONSTRUCTION!

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

ENVIRONMENTAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: 7-23-74

Site: C-1, Parameters (Area) Surveyed: soil erosion 400 values

The subject site has been surveyed for environmental baseline conditions and the findings are as follows:

1. Terrestrial: Vegetation Sagebrush with occasional Juniper

2. Wildlife: cattle, deer, rabbit

3. Aquatic: no water present in area

Method Used:

1. Terrestrial:

2. Wildlife:

3. Aquatic:

Recommendations: proceed with drilling operations

David Winsor

Dave Winsor
Environmental Ecologist

Dr. Alan Olson
Archeologist
Observer

ENVIRONMENTAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: 7-22-74

Site: C10 new access road, Parameters (Area) Surveyed: 30 ft corridor

The subject site has been surveyed for environmental baseline conditions and the findings are as follows:

1. Terrestrial: same as described in C-10 some Juniper appear to be rather ancient (300 yrs old)

2. Wildlife: " " " "

3. Aquatic: no ~~flow~~ water present

Method Used:

1. Terrestrial:

2. Wildlife:

3. Aquatic:

Recommendations: proceed with clearing for road.

David Winsor

Dave Winsor
Environmental Ecologist

Dr. Alan Olson
Archeologist
Observer

ARCHEOLOGICAL SURVEY ON

GULF-STANDARD HEAT Co.

Date of Survey: JULY 20, 1974

Site: CH 14 & 15, Parameters (Area) Surveyed: 300' R; ROAD 35'

The subject site has been surveyed and the findings are as follows:

ARCHAEOLOGICALLY NEGATIVE ON BOTH COREHOLE SITES AND ACCESS ROADS.

Method Used:

SURFACE SURVEY.

Recommendations:

ARCHAEOLOGICALLY, THE ROADS & SITES ARE CLEARED FOR CONSTRUCTION. HOWEVER, A HERD OF NINE WILD HORSES LED BY THE SAME STALLION PREVIOUSLY SIGHTED NEAR CH 10 WERE OBSERVED. LIMNETICS HAS BEEN NOTIFIED ABOUT THE HORSES.

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

ENVIRONMENTAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: 7-22-74

Site: C-14 & access roads, Parameters (Area) Surveyed: 400 radius of core 30 Foot corridor to core

The subject site has been surveyed for environmental baseline conditions and the findings are as follows:

1. Terrestrial: Vegetation - Sagebrush community with additional species ie. scarlet gilia, indian paintbrush, and numerous grasses. Land of P-J near core hole

2. Wildlife: groundsquirrels signs of horses and other livestock, lizards (Sceloporus + Phrynosoma)

3. Aquatic: No water in area

Method Used:

1. Terrestrial:

2. Wildlife:

3. Aquatic:

Recommendations: proceed with drilling operations. Care should be taken to go in between the land of P-J near the core hole as marked by Gene Ziemba.

David Winsor

Dave Winsor
Environmental Ecologist

Dr. Alan Olson
Archeologist
Observer

ENVIRONMENTAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: 7-22-74

Site: C-15 + access road, Parameters (Area) Surveyed: 400 [illegible] of [illegible] hole 30 ft corridor to cor. hole marker

The subject site has been surveyed for environmental baseline conditions and the findings are as follows:

1. Terrestrial: topography - hilly with [illegible] valleys. Vegetation ranged from PJ community on hilltops to sagebrush on hillsides.

2. Wildlife: indication of horses, deer, porcupine, chipmunks, ground squirrels, golden eagle and lizards (see C-14)

3. Aquatic: creek beds present however no water was running

Method Used:

1. Terrestrial:

2. Wildlife:

3. Aquatic:

Recommendations: proceed with drilling operations

David Winsor

Dave Winsor
Environmental Ecologist

Dr. Alan Olson
Archeologist
Observer

ARCHEOLOGICAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: SEPT. 5, 1974

Site: S5 + PROPOSED ACCESS, Parameters (Area) Surveyed: 300'R

The subject site has been surveyed and the findings are as follows:

AREA LOCATED IN SHALLOW DRAINAGE DRAINING A BASIN, 300-400' BELOW RIDGE TOPS. NEGATNE ARCHAEOLOGICALLY

Method Used:

SURFACE SURVEY

Recommendations:

INSTALLATION OF EQUIPMENT

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

ARCHEOLOGICAL SURVEY ON

GULF STANDARD TRACT C-a

Date of Survey: SEPT 5, 1974

Site: M1, Parameters (Area) Surveyed: 300' R

The subject site has been surveyed and the findings are as follows:

AREA LOCATED ON NORTH FACING SLOPE OF RIDGE APPROXIMATELY ~~B~~ 300' BELOW THE CREST NO ARCHAEOLOGICAL

Method Used:

SURFACE SURVEY

Recommendation:

CONSTRUCTION BE ALLOWED.

Alan P. Olson

Dave Winsor

Dr. Alan Olson
Archeologist

ARCHAEOLOGICAL SURVEY OF

GULF FEDERAL PROJECT

Date of Survey: SEPT 5, 1974

Site: M3, Parameters (Area) Surveyed: 300' R

The subject site has been surveyed and the findings are as follows:

SITE LOCATED AT THE INTERSECTION OF A STEEP NORTH FACING RIDGE FACE AND THE VALLEY BOTTOM. NO FINDINGS ARCHAEOLOGICALLY.

Method Used:

SURFACE SURVEY.

Recommendations:

INSTALLATION OF EQUIPMENT APPROVED

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

Date: SEPT 4, 1974

M2, S10 300'R

Title: NEGATIVE FOR ADJ ARCHAEOLOGICAL WATERLINE

Method:

SURFACE SURVEY

Per:

INSTALLATION OF TEST EQUIPMENT APPROVED

Prepared by: G. Alan Olson
Archaeologist
Date:

ARC[illegible] SURVEY OF

CULT[illegible]

Date of Survey: SEPT 4, 1974

New location: NW ¼ Sec 21, R [illegible] E, W.M., Township [illegible] N

Site: METEOROLOGICAL STA 4 , Parameters (Area) Surveyed: 300' R.

The subject site has been surveyed and the findings are as follows:

NEW SITE LOCATED AT W END OF WHAT APPEARS TO BE AN ABANDONED AIRSTRIP 60 X .5 MILES. AREA IS [illegible] DISTURBED & NO ARCHEOLOGICAL MATERIAL WAS FOUND WITHIN THE AREA DESCRIBED. IF ACCESS TO SITE [illegible] ION FOLLOWS THE LOGICAL ROUTE, IT WILL [illegible] DISTURBED GROUND.

Method Used:

[illegible] SURVEY

Recommendation:

INSTALL [illegible] EQUIPMENT

Dave Winzer
Terrestrial Ecologist
Observer

Alan P Olson

Dr. Alan Olson
Archeologist
Surveyor

[illegible]

[illegible]

Date of Survey: OCT 6, 1974

Site: S4, Parameters (Area) Surveyed: 200'R

The subject site has been surveyed and the findings are as follows:

NO ARCHAEOLOGICAL REMAINS WERE FOUND IN THE SHALLOW DRAINAGE OR THE SURROUNDING SLOPES

Method Used:

SURFACE SURVEY

Recommendations:

WELL MAY BE DUG

Alan P. Olson

Date Signed:
Terrestrial Archeologist
Observer:

Dr. Alan Olson
Archeologist
Surveyor

Date of [illegible] SEPT 6, 1974

Site: S3, Parameters (Area) Surveyed: 200'R

The subject [illegible] surveyed and the findings are as follows:

SITE LOCATED IN A DEEP ARROYO

NO ARTIFACTUAL MATERIAL WAS FOUND

Method [illegible]:

SURFACE SURVEY

Recommendations:

CONSTRUCTION MAY PROCEED

[illegible]

Terrain: [illegible]

Observers: [illegible]

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

SEPT 6, 1974

S2 ZCC'R

NO ARCHAEOLOGICAL MATERIAL FOUND

SURFACE SURVEY

INSTALLATION OF EQUIPMENT MAY PROCEED.

Alan P. Olson

WARNING
NOTICE

Date of [illegible] 9/5/74

Site: Historic Horse Trap . Parameter (Area) Surveyed: ca 200 yds E-W, 100 yds N-S

The subject site has been surveyed and the findings are as follows:

~~Site~~ located immediately south of the present access road on Dead Horse Ridge, in the NE¼ of NE¼ of Sec. 29, R99W, T1S, approximately 1 mile ~~west of~~ the location of Station M4. The site is a winged horse trap with cable reinforcement and a catch and holding corral that is also ~~cable~~ reinforced using natural trees and additional wooden elements. The site is not terribly old and has not been used for some time, but it is in a good state of preservation and should not be damaged. The area has also been extensively used as a deer camp area with attendant trash. Any expansion of the present road to the south would present a danger to the site.

Method Used:

Surface Survey.

Recommendations:

That this area be flagged out and avoided prior to the time of road ~~expansion. The site is easily recognizable and should present no~~ problem.

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

Date: SEPT 6, 1974

Site: S2 300'R

The [illegible]

NO ARCHAEOLOGICAL MATERIAL FOUND

Method [illegible]

SURFACE SURVEY

Recommendation

INSTALLATION OF EQUIPMENT MAY PROCEED

Dave Finco
Terrestrial [illegible]
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

ARCHEOLOGICAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: SEPT 6, 1974

Site: S3, Parameters (Area) Surveyed: 300'R

The subject site has been surveyed and the findings are as follows:

SITE LOCATED IN A DEEP ARROYO.
NO ARTIFACTUAL MATERIAL WAS FOUND.

Method Used:

SURFACE SURVEY.

Recommendations:

CONSTRUCTION MAY PROCEED.

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

ARCHEOLOGICAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: SEPT 6, 1974

Site: S4, Parameters (Area) Surveyed: 300'R

The subject site has been surveyed and the findings are as follows:

NO ARCHAEOLOGICAL REMAINS WERE FOUND IN THE SHALLOW DRAINAGE OR THE SURROUNDING SLOPES.

Method Used:

SURFACE SURVEY

Recommendations:

WELL MAY BE DUG.

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

ARCHEOLOGICAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: SEPT. 4, 1974

Site: S9, Parameters (Area) Surveyed: 300'R

The subject site has been surveyed and the findings are as follows:

TEST SITE IN ARROYO NEGATIVE.
BENCHES ON EITHER SIDE OF ARROYO ALSO
NEGATIVE.

Method Used:

SURFACE SURVEY

Recommendations:

CONSTRUCTION BE ALLOWED.

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

ARCHEOLOGICAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: SEPT 4 1974

New loc. in NW ¼ sect 21; RANGE 98 West, TOWNSHIP 1 SOUTH

Site: METEOROLOGICAL STA. 4, Parameters (Area) Surveyed: 300' R

The subject site has been surveyed and the findings are as follows:

NEW SITE LOCATED AT W END OF WHAT APPEARS TO BE AN ABANDONED AIR STRIP 60' X .5 MILES. AREA IS ALREADY DISTURBED & NO ARCHAEOLOGICAL MATERIAL WAS FOUND WITHIN THE AREA DESCRIBED. IF ACCESS & SITE LOCATION FOLLOWS THE LOGICAL ROUTE, IT WILL ALL BE OVER DISTURBED GROUND.

Method Used:

SURFACE SURVEY

Recommendations:

INSTALLATION OF EQUIPMENT

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

Date of Survey: SEPT 4, 1974

Site: M2, S10, Parameter (Area) Surveyed: 300' R

The subject site has been surveyed and the findings are as follows:

NEGATIVE FOR ANY ARCHAEOLOGICAL MATERIAL

Method Used:

SURFACE SURVEY

Recommendations:

INSTALLATION OF TEST EQUIPMENT APPROVED

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

ARCHEOLOGICAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: SEPT 5, 1974

Site: M1, Parameters (Area) Surveyed: 300' R

The subject site has been surveyed and the findings are as follows:

AREA LOCATED ON NORTH FACING SLOPE OF RIDGE APPROXIMATELY ~~B~~ 300' BELOW THE CREST NO ARCHAEOLOGICAL

Method Used:

SURFACE SURVEY

Recommendations:

CONSTRUCTION BE ALLOWED.

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

ARCHEOLOGICAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: SEPT 5, 1974

Site: M3, Parameters (Area) Surveyed: 300' R

The subject site has been surveyed and the findings are as follows:

SITE LOCATED AT THE INTERSECTION OF A STEEP NORTH FACING RIDGE-FACE AND THE VALLEY BOTTOM. NO FINDINGS ARCHAEOLOGICALLY.

Method Used:

SURFACE SURVEY.

Recommendations:

INSTALLATION OF EQUIPMENT APPROVED.

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

ARCHEOLOGICAL SURVEY ON

GULF-STANDARD TRACT C-a

Date of Survey: SEPT. 5, 1974

Site: S5 + PROPOSED ACCESS, Parameters (Area) Surveyed: 300'R

The subject site has been surveyed and the findings are as follows:

AREA LOCATED IN SHALLOW DRAINAGE DRAINING A BASIN, 300-400' BELOW RIDGE TOPS. NEGATNE ARCHAEOLOGICALLY.

Method Used:

SURFACE SURVEY

Recommendations:

INSTALLATION OF EQUIPMENT.

Dave Winsor
Terrestrial Ecologist
Observer

Alan P. Olson

Dr. Alan Olson
Archeologist
Surveyor

LIMNETICS, INC.
environmental consultants

RECEIVED
1 0 1975
OFFICE OF
AREA OIL SHALE SUPERVISOR
U.S. G.S.

February 4, 1975

D-311
74-948
File 14.3

Mr. Dale R. Andrus
State Director
Bureau of Land Management
Room 700
Colorado State Bank Building
1600 S. Broadway
Denver, CO 80202

Dear Mr. Andrus:

Enclosed is a copy of the archaeological survey made by Cal Jennings on December 3. This survey was made to report on the three exclosure pens in the process of construction on Tract Ca. It is my understanding these copies have already been submitted to your office on December 17, but unfortunately our contractor, ECI has just forwarded this information to our office.

The results of this survey indicated that no notable or significant archaeological items were uncovered.

If you have any questions on Mr. Jennings report, please get in touch with me.

Sincerely,

Donald R. Millert

Donald R. Millert,
Project Manager
DRM/bj

cc: Mr. Ed Sandel
Dr. Olson
Dr. Schwendinger
Dr. Harmsworth

9025 East Kenyon Avenue, Denver, CO 80237 • Phone 303/770-6253

REPORT ON THE CULTURAL RESOURCES OF THREE EXCLOSURE PENS NEAR THE Ca OIL SHALE LEASE TRACT

Laboratory of Public Archaeology
Colorado State University
Project No. 74-10
Rio Blanco County

The following is a report on an archaeological survey conducted by the Laboratory of Public Archaeology for Ecology Consultants, Inc., in the Piceance Basin of northwestern Colorado. Authorization to do the field work comes under Federal Antiquities Permit 74-CO-55, issued to Colorado State University by the Bureau of Land Management, U.S. Department of the Interior. The reconnaissance, which examined two sites proposed for pen consturction and a third at which the pen had already been built, was designed to assess the nature and extent of the cultural resources likely to be affected by construction of the pens. The resource would manifest itself in the form of artifacts and/or architectural features left behind by aboriginal or early Euro-american occupants of the area.

Man-Days Input

The field work was undertaken and completed on December 3, 1974, at the cost of one man-day labor. Another two man-days were involved in the preparation for the porject and report writing.

Description of the Exclosure Pens

Exclosure Pen No. 1: This pen is located in T2S, R99W, SWSE of Sec. 5 and NWNE of Sec. 8. (UTM coordinates: 4419220m N, 711600m E.) The pen is on a northeast facing slope overlooking Boxelder Gulch. The locality produced no evidence of cultural resources.

Exclosure Pen No. 2: Pen 2 is located in T2S, R99W, SWNE of Sec. 7. (UTM coordinates: 4418480m N, 710150m S.) Proposed Pen No. 2, situated on the

northern slope of an unnamed ridge to the south of Corral Gulch, was not demarcated at the time of the survey. Consequently, the survey was conducted along fence lines flagged at the time of the archaeological reconnaissance. No archaeological sites or materials were discovered in the projected construction area.

Exclosure Pen No. 3 T1S R99W Sec. 29 NENE. UTM Coordinates: 4424000M N., 711800M E.. Proposed Exclosure Pen No. 3, located on the northeastern slope of Dead Horse Ridge adjacent to Big Duck Creek, was also void of flagging. The projected area of construction and fence lines were laid out, after which the survey was conducted. Archaeological materials and sites were absent within the confines and fence lines of the proposed exclosure pen.

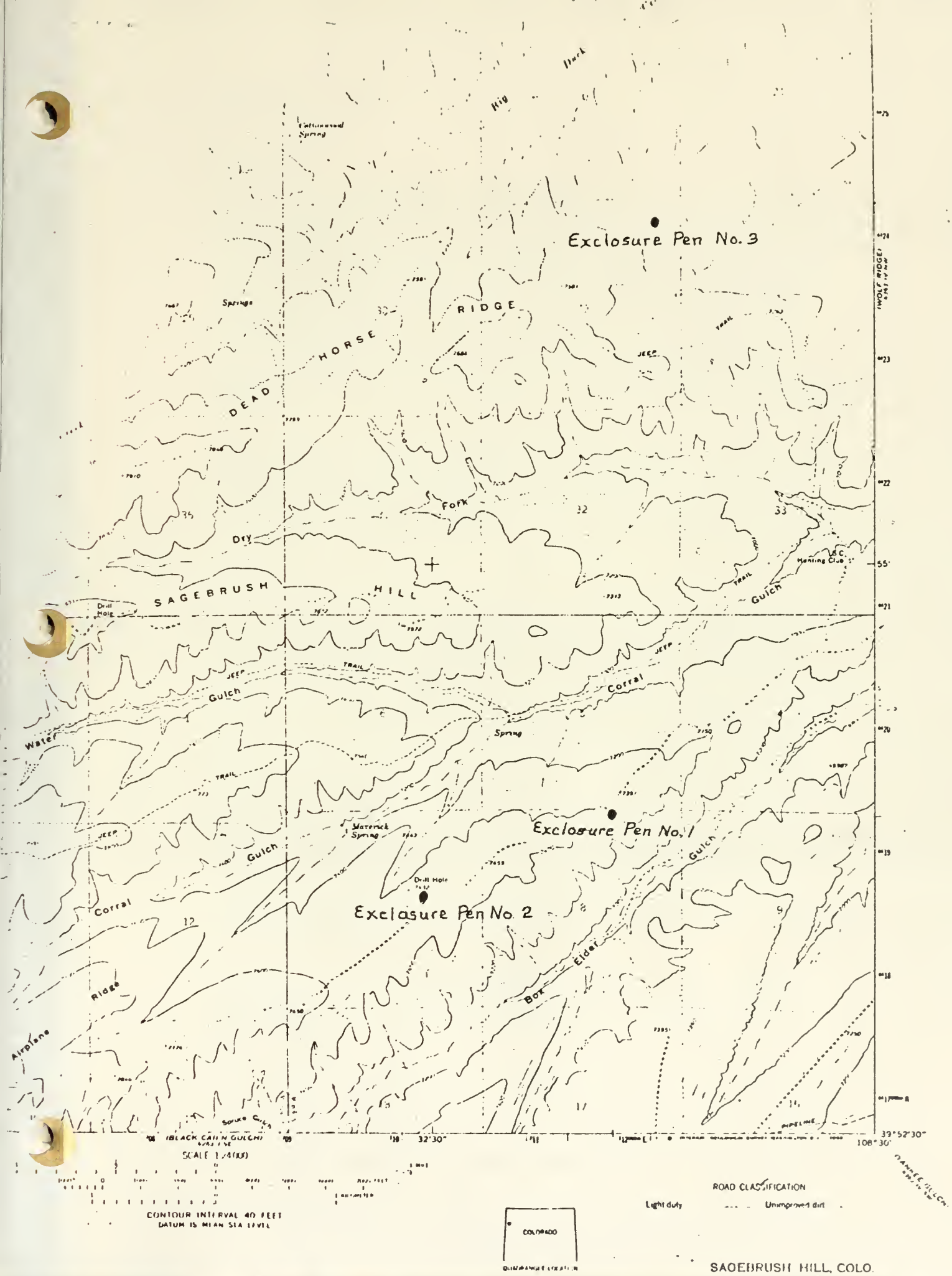
Conclusion

An absence of archaeological sites, materials, or significant cultural resources within the proposed and constructed areas of the exclosure pens, numbered #1, #2 and #3, precludes any recommendation of a mitigating nature. On archaeological grounds, the clearance for the initiation of construction activity is hereby granted.

Submitted by:

Robert W. Leonard

December 9, 1974



THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR WASHINGTON, D.C. 20242

2.5.3 REVEGETATION

2.5.3.1 Objectives

In accordance with good rehabilitation practices, to meet the lease stipulations, and as an obligation to mitigate environmental impacts due to mining and processing operations, all portions of lands which have been disturbed by these operations will be revegetated. This includes the temporary revegetation of processed oil shale, overburden and topsoil stockpiles; and the establishment of a stable ecosystem on the spent shale-overburden-topsoil rehabilitation sites and the sites with minor surface disturbances (e.g., corehole pads and access roads).

The revegetation research program must address and provide answers to engineering problems directly related to the disposal of spent shale which will allow Rio Blanco to take the necessary steps to develop a viable rehabilitation program.

2.5.3.2 Methods

In the development of a revegetation program of this magnitude, historical information must be obtained through a literature review and search. Prior to the initiation of the Tract Ca studies, abstracts and periodicals obtained must be accumulated, stored, abstracted and summarized to identify experimental designs which have been successfully used in revegetation studies. Areas where additional field and laboratory experimental studies must be performed will be defined. Through literature review, feasibility of certain revegetation programs and qualified investigators can be identified. Prior established field sites will be visited, inspected, and evaluated. The studies in this revegetation program will be directly related to the mining and processing methods used in the Tract Ca operation, and the effects of local geology, climatology and revegetation.

During the late spring and summer of 1975, various types of revegetation studies will be initiated on Tract Ca. Some of the revegetation studies presently under consideration are:

1) The reseeding of disturbed areas, such as corehole pads, with mixtures of native and exotic grasses, and other corehole pads with mixtures of grasses, native forbs and shrubs. This seeding will be accomplished after the area has been reshaped.

The purpose of these and other studies is to determine procedures and methods which may be used in the future for revegetation of areas with minor surface disturbances.

These studies may identify various seeds which will germinate and grow under natural conditions, without additional water and utilizing native topsoil as a growing medium. Other studies will determine the water requirements of these plants through water amendment plots established on the corehole pads. Some of the pads will be mulched after seeding to assess the benefits of mulch covers on seed germination and establishment, and erosion control in this area.

2) The many sites within the area of the leased tract which have been subjected to various types of disturbances in the past years will be studied. These disturbed sites (e.g., air strips, drill pads, old roads, pipleine corridors) may offer an immediate view of the natural sequence of revegetation, through comparison of species composition on sites disturbed at different times. Estimates of the time necessary for different stages of succession on various soil types can be made from these comparisons. This information will be useful in evaluating revegetation programs for this region.

3) Spent shale from different retorting methods will be used for the study of temporary revegetation of spent shale piles to determine the effects of underlying spent shale on the germination and growth of native and exotic plants in overburden. A portion of this study will be carried out in the laboratory.

2.5.3.3 Results

The results from literature surveys, site inspections, and experimental plots should answer the following questions:

1) What are the effects of wind and water erosion on spent shale overburden and topsoil?

2) What is the quantity and quality of water required for revegetation and how long will it need be applied for successful establishment of plants?

3) How much overburden and topsoil is available? What are their physical and chemical characteristics? What are the optimal mixtures for successful plant establishment?

4) What is the amount and depth of leaching of spent shale and the effect of leachates on ground water? What are the tendencies of spent shale salts to move to the surface and their effects on the vegetation?

5) What are the effects of soil disruption on soil flora and fauna? What procedures need be implemented to re-establish the soil system prior to, or concurrent with, revegetation activities?

6) What is the plant species composition of the proposed revegetation community? What plant species should be used for the temporary stabilization of the stockpiles?

7) What is the best configuration (degrees of slope, aspect, terracing, water collection areas, etc.) for the spent shale disposal site to assure successful revegetation?

8) What are the effects of mulches, fertilizers and water amendment on seed germination and seedling establishment?

9) Are there alternative methods for establishing native perennials which are more rapid than growing from seeds? Which native perennials are conducive to revegetation propagation?

Other questions will arise as this revegetation program progresses. The flexibility built into the program allows for emphasis to be shifted to new and important questions which need immediate attention. Results from the revegetation research program will be incorporated into the overall engineering and rehabilitation plans and will be outlined as a preliminary revegetation program in the Detailed Development Plan.

2.5.4 TOXICOLOGY

2.5.4.1 Objectives

An animal testing program will be performed to evaluate the environmental health effects of an oil shale industry and to obtain data which would form the basis for a sound industrial hygiene program. The proposed plan of evaluation is designed to meet Rio Blanco Oil Shale Project's most immediate needs of defining toxicity problems, primarily as they relate to man.

Materials related to both the Tosco II and the Paraho process will be evaluated. Raw oil shale, raw organic matter (kerogen plus extractables), spent shale (TOSCO II and Paraho), total shale oil (TOSCO II and Paraho), and water extract of spent shale will be included in the tests.

2.5.4.2 Methods

(a)	Toxicology Screen:	- acute oral and inhalation (rats). - acute dermal and eye (rabbits).
(b)	Subacute toxicity	- two week dermal test in rabbits. - four week inhalation -- 2 species. (rats and monkeys); one concentration.
(c)	Sensitization	- Human patch tests for allergic contact dermatitis photosensitization.
(d)	Chronic toxicity	- lifetime skin painting in mice -- groups of 50 animals including positive and negative controls. - two year inhalation (3 test levels, rats and monkeys, dust exposure, evaluations to include clinical chemistry, respiratory physiology, pathology, chemical analyses of tissues and chamber dust sampling.)
(e)	90-day feeding water extract of spent shale	- 3 levels -- rats and dogs.

2.5.4.3 Results

The toxicity testing program will begin within a few months. Some test results will be available within a few months after start-up. The more significant tests (e.g., carcinogencity by skin painting and inhalation toxicity) require 80 weeks and 2 years respectively.

2.5.5 TRACE METALS

Trace metal analysis will be performed on a step-wise basis. Soils will be analyzed for metals. If any are found in sufficient quantities, then plants will be analyzed. If sufficient amounts are found in plants, then a first level herbivore will be analyzed and so forth.